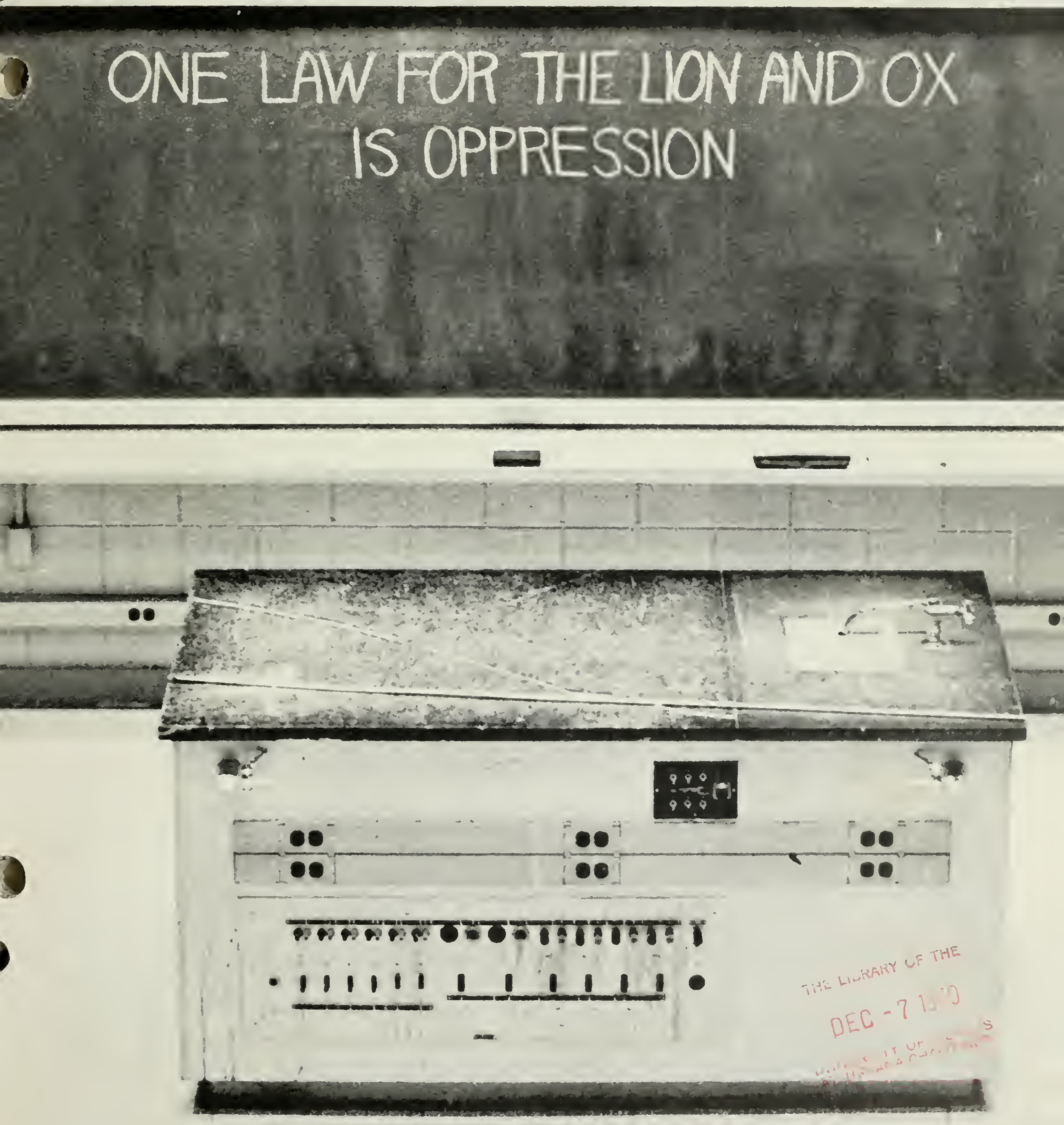
TECHNOGRAPH



What I like about Celanese is the professional elbow room.

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Who can say? All I know is I'm busy doing something worthwhile. I'm moving. I'm helping to make things happen.

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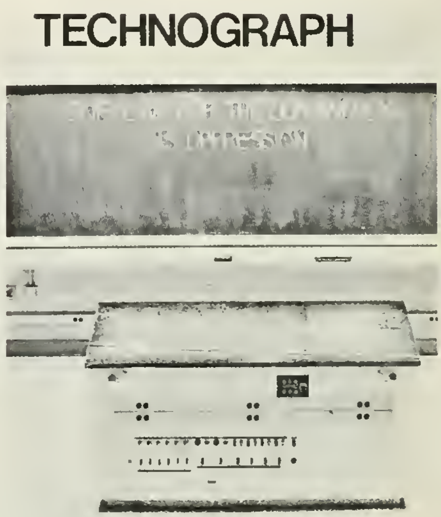
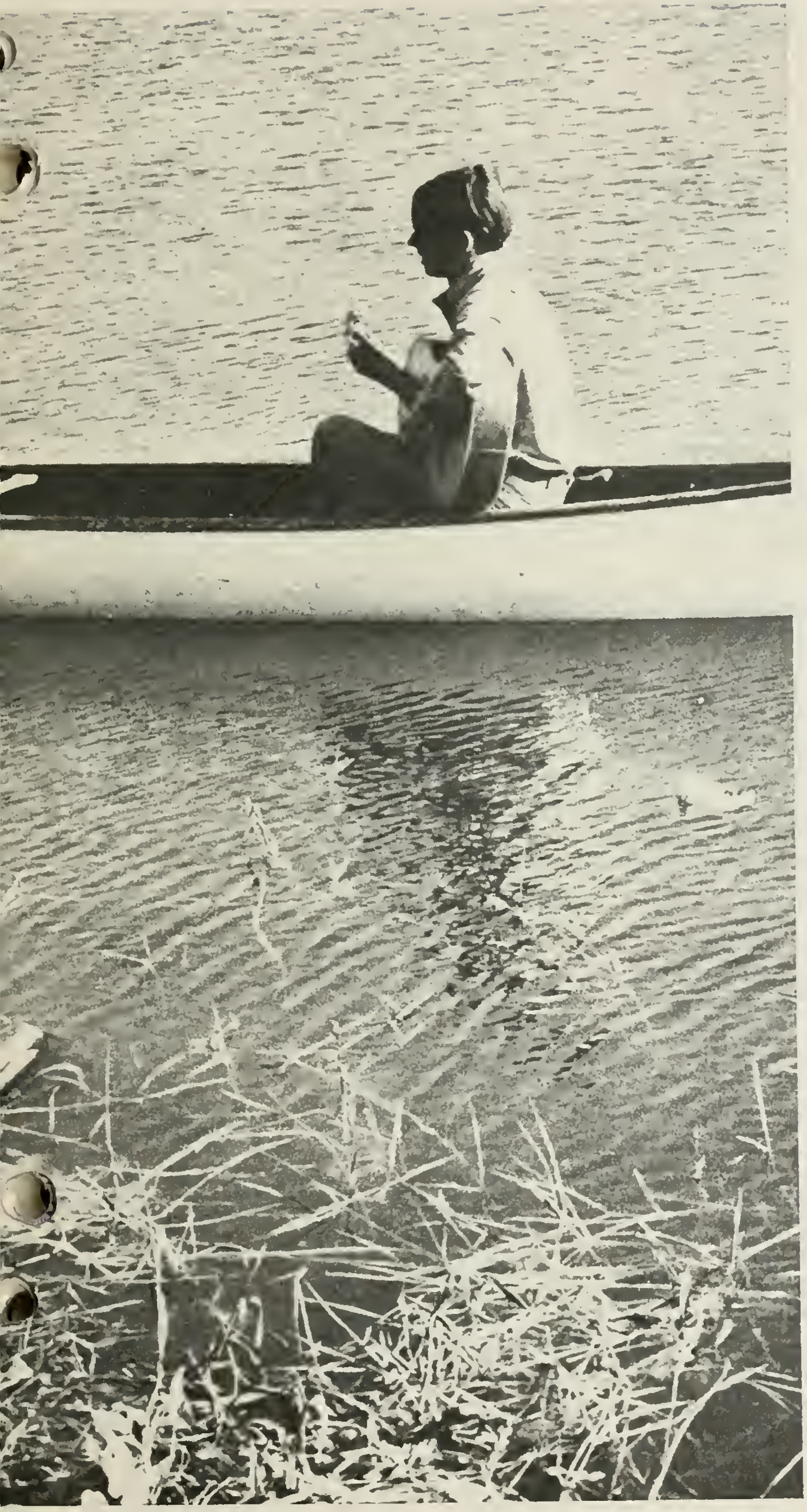
COVER

The cover shows what the new golden rule for education must be. Thanks to William Blake for the quote and to Mike Frett and John Mendenhall for the artwork.



Goodbye, lake.

PHOTO: JOHN HARRISON



In The Wind

Because the editor did not feel up to writing his usual biting editorial, we rummaged through the files and came up with the following exceprts from some University publications which we thought few students have ever seen.

Our World and Welcome to It: The Official House Organ of the College of Engineering. Vol. 30, No. 2, October 30, 2000.

Engineering education at Illinois in the year 2000 might scarcely be recognized by the alumni of 20 or 30 years ago. Phenomenal changes have occurred both in the curriculum and in the students themselves. The average freshman entering today's 8-year, 300-hour engineering curriculum is far better prepared by his high-school background in Boolean algebra and nuclear physics than his predecessors ever were. The mere challenge of using the 48-scale, 3-foot slide rule required for everyday computations might have seemed insurmountable to the student of 30 years ago. In addition to this technical superiority, however, the engineer of 2000 possesses a more enlightened view of the sociological and psychological aspects of engineering problems. This broader vision is derived, in great part, from the full 30 hours of required courses in the humanities and social sciences.

Research engineers at Illinois have produced devices and techniques that have revolutionized the world's standards of living. Thanks to new concepts in gas mask design developed at Illinois, the air we all breathe is the cleanest it has been since the Sino-American war of 1984. Improvements in hybrid strains of corn and wheat developed by the Agricultural Engineering Department at Illinois helped cut the 1999 death toll in ecologically battered China to a 5-year low of 92 million. With the aide of a 40 billion dollar grant from the Pentagon, electrical engineers and mathematicians at Illinois developed Illiac VIII. When completed Illiac VIII could instantaneously mobilize America's nuclear defenses and initiate a nuclear strike if deemed necessary. *Science* magazine recently credited new alloys developed by metallurgist at Illinois with helping cut the number of deaths from radiation leakages to nuclear plants to less than 20,000. And the list of improvements stretches on...

For The Record

One law. Although the title of this issue refers to an attitude toward education, it might equally easily apply to the *Technograph's* editorial policy. We cannot pretend that everyone will agree with all the ideas presented in the magazine, nor do we ask people to agree. Articles in the *Technograph* seek to establish a valid viewpoint on a specific subject. Whether the reader agrees or disagrees with this viewpoint is irrelevant, at least as far as the journalistic aspect is concerned. Of course the quality of the magazine is greatly enhanced by presenting a balanced issue. Unfortunately it is not always feasible or possible to present opinion A in direct apposition to opinion B.

I must stringently object with those who have maligned the *Technograph* for presenting a distorted view of the College. The fact that an article appears in the magazine does not imply that an author's viewpoint is correct. It simply means his opinion has merit, and probably should be presented. The duty, therefore, rests not with the author, but with the reader. If at times it seems that the magazine's perspective seems to rest consistently on one side, the complaint should be charged to a lack of vocal critics who are willing to express their opinions in print. The burden lies with the reader as much as it does with the writer.

Thus, anyone who disagrees with something published in the magazine has a duty, not merely an opportunity, to express his view, assuming that the disagreement betw en the views is significantly great. Because we feel that *Technograph* has opened the forum to free discussion, we will not appreciate tales of faculty complaining to their department heads, department heads griping to the Deans, or students wasting their comments in idle bull sessions. Tell us what you disagree with. Formulate your ideas in a clear, concise letter. If you can demonstrate that a specific article substantially misrepresents an issue, you might be able to write a full article for the magazine.

We will not impose one law on our readers--if they do not let us.


You'll never have to ask what's new
if you work for a company like this.

Education Beyond Efficiency

by Galen Rath

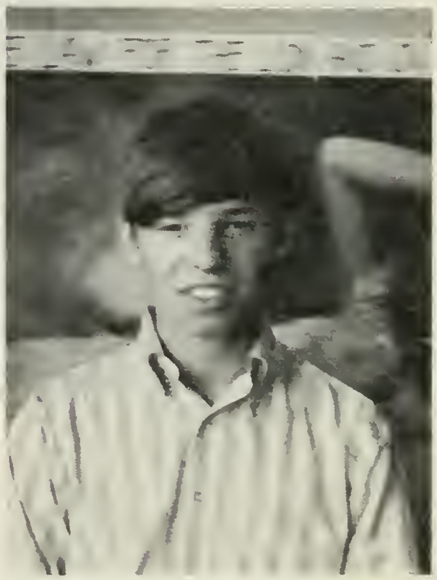
Ecological Source Book, published by Engineering Ecology 297 and 497, Spring 1970: "We find that the University does moderately well in training specialists--engineers, artists, agronomists--some of whom will certainly have a part in bettering the world, but that it fails to do so nearly as well in educating students outside their specialties....Who will teach the engineering student to develop a sense of the esthetic that goes beyond mere efficiency ...to utilize the skills of technologists in meeting society's needs?"

The problem is recognized. The engineering graduate is entering leadership roles which demand a broader understanding of, and responsibility to, society. Perhaps his eighteen required hours in social sciences, humanities, and economics is a limiting factor in his ability to approach human problems with the same fine competence that he applies to his technical problems. The university has the opportunity, if not the responsibility, to instill in the individual a social awareness.

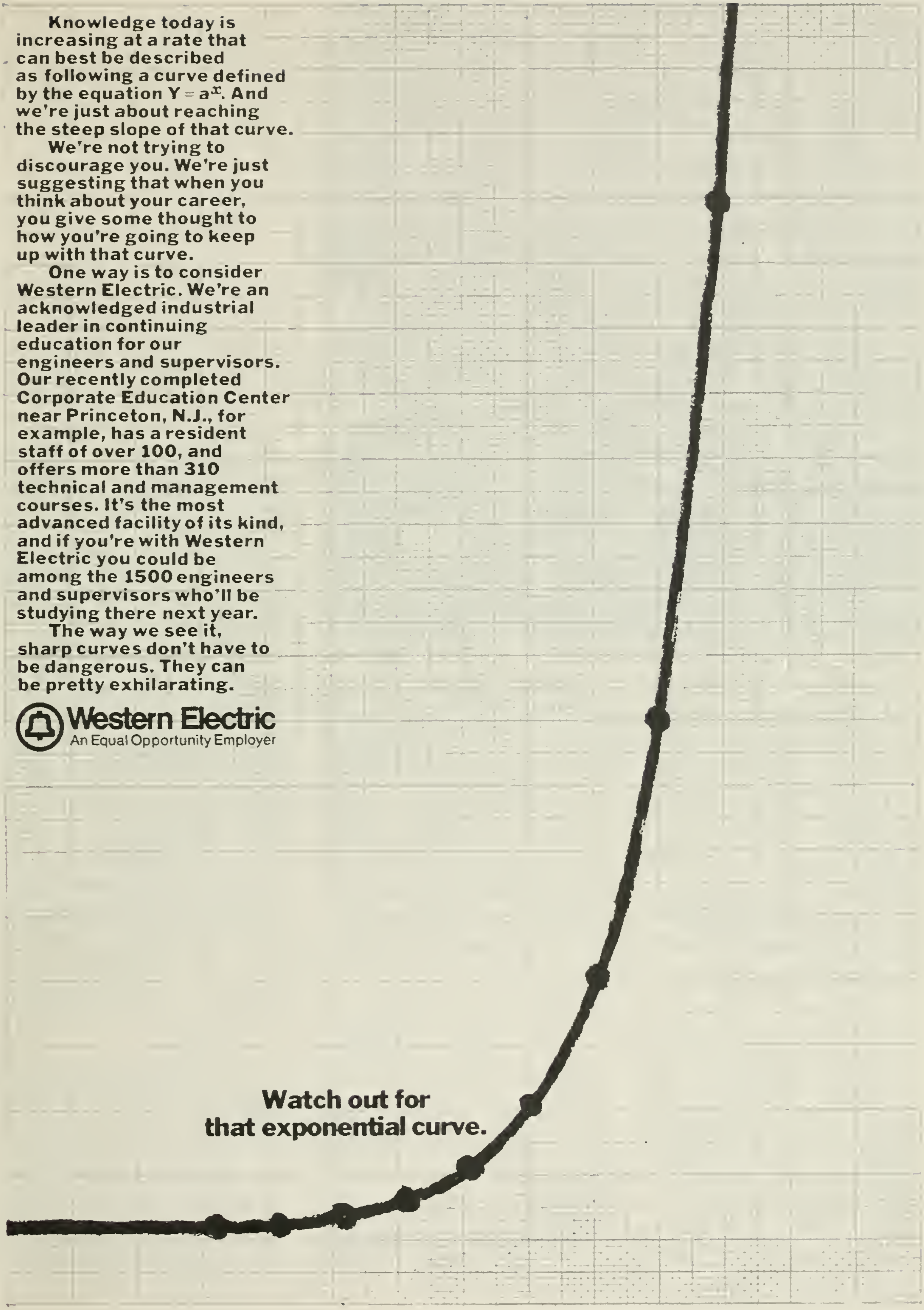
The Five-Year Combined Engineering-Liberal Arts and Sciences Program, in allowing engineers to major in an LAS curriculum as well, was formulated explicitly to serve this end. The College of Engineering feels that the addition of an LAS major tends to reorientate the technical character of the classical four-year engineering program. In this way, the engineer may learn to cooperate with people better and perhaps develop attitudes more responsive to social need.

Thus, through the program, the engineer selects a major in the LAS college and after completing an integrated five-year study program, he is awarded two separate degrees, one in Liberal Arts and Sciences and one in Engineering. Providing not only a well-rounded cultural background for the engineer, this combined nature of the program also allows students to pursue an inter-disciplinary education in preparation for a variety of unique, new careers.

What are some of the possibilities? An industrial engineering curriculum integrated with a psychology major would prepare the student for a career in engineering psychology or industrial management. Aeronautical engineers interested in artificial environments, ocean engineering, or environmental engineering might major in biology. Hoping to work overseas in an underdeveloped nation, a civil engineer would perhaps



Galen Rath


Knowledge today is increasing at a rate that can best be described as following a curve defined by the equation $Y = a^x$. And we're just about reaching the steep slope of that curve.
We're not trying to discourage you. We're just suggesting that when you think about your career, you give some thought to how you're going to keep up with that curve.
One way is to consider Western Electric. We're an acknowledged industrial leader in continuing education for our engineers and supervisors. Our recently completed Corporate Education Center near Princeton, N.J., for example, has a resident staff of over 100, and offers more than 310 technical and management courses. It's the most advanced facility of its kind, and if you're with Western Electric you could be among the 1500 engineers and supervisors who'll be studying there next year.
The way we see it, sharp curves don't have to be dangerous. They can be pretty exhilarating.
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that exponential curve.

want to take Asian studies courses to acquaint himself with the real needs of the people in Asiatic countries. He might take a political science program if his interest lean toward an engineering-related position in the government. Combinations with philosophy, sociology, physiology, Russian and other languages, anthropology, and premedicine set the stage for undergraduate programs in biomedical engineering, environmental controls, human factors engineering, and others.

Anyone in engineering or LAS can enroll in the program, if he has at least a 3.5 grade point average and if he has not taken over 75 hours. Since certain courses must be taken in specified sequences to insure that students graduate in five years, the university prefers students to enter the program early.

Regular freshman engineering courses fill the first year, liberal arts and sciences courses in the selected LAS major are taken the second and third years of study, and the engineering requirements for graduation are completed during the last two years.

That the program can be completed in five years is due to the fact that the requirements in rhetoric, social sciences, and humanities are basically the same for both colleges. Mathematics and chemistry requirements in engineering well exceed the requirements in LAS. Thus, the engineer would ideally have only to complete an additional eight hours in biology, eight hours in language, and 20 hours in his LAS major to qualify for his LAS degree. "Every engineering student," says Dean Bokenkamp, "could get the LAS degree by going one more year."

But the program is rigorous, and some students do find it hard to complete in five years. "The average time in the regular program is four and a half years, and they add 40 hours to that and expect you to make it in five years," says Galen Foat, President of the Engineering Council last year, and an electrical engineering-psychology major in his fifth year of the program. "You have a few too many hours to complete, and sometimes there's really no way." He says he would have to take 26 or 27 hours next semester to graduate in five years.

Courses in the program are generally very time-consuming, and in particular, Foat notes that the language courses during your sophomore and junior years do demand a lot of time if you want to do well in them, and that it really gets rough when you take engineering courses with problem sets at the same time.

Although some may think the program broadens your choices of classes, it actually tends to narrow your choices to a degree, and Foat finds this limited choice to be somewhat of a disadvantage. He added though that it is something you are willing to give up to pursue a good interdisciplinary program.

Dean Bokenkamp is aware of the limited number of electives available, and explains that since the courses you choose must satisfy the requirements of both colleges, your choice of electives is consequently narrow Your major in LAS is actually your elective.

Commenting on the positive aspects of the program, Foat says that in addition to his studies in personal and social psychology he gained quite a bit from his general courses in social sciences and humanities and from courses in European history and Russian. One of the primary assets of the

Dean Bokenkamp

program is that it provides "a general awareness of what's on the other side of Green Street."

And if his choice of electives was narrowed, his choices of areas of graduate study correspondingly broadened, since he has the opportunity of continuing in about 15 different areas.

"The Engineering-LAS degree program is not a watered-down program in either LAS or engineering," says Dean Bokenkamp. Generally the course loads average 17-18 hours rather than 14 or 15 as in the four-year LAS and Engineering programs, and the content of the program is more comprehensive due to a minimum of electives "The program is not for people who do not know what they want." Commenting further, he notes that students who come into the program exploring usually become discouraged and drop.

The Dean says that the students who take the program seem to be "people who are visionary," if only because many are entering study courses for jobs that are still very visionary in nature.

The Dean finds that the students in the program are generally the better students and therefore able to carry heavy loads. Because many take correspondence courses, attend summer sessions, and proficiency several courses, the average time spent by the 50-75 students in the program to complete requirements for both colleges is five years. One engineering-mathematics major, for instance, will complete his studies in four years. Most of the program's participants go on to graduate studies, which the Dean says again indicates that most of the students are very academically oriented.

But the program is for all students, and Dean Bokenkamp's first comment was that he encouraged everyone to consider the program. The interests of the student is again the primary concern. The student should, however, question his ability to complete the program successfully, and the Dean thinks everyone should ask himself if he could spend his time better by going in another direction. One could get his Masters Degree in the same five years, for instance.

"It is a great program for a person who has a goal which can be reached by an interdisciplinary approach," says Dean Bokenkamp.

But while the program does allow the engineer to tailor his education for a particular type of job he is seeking, the primary value of the Five-Year Combined Engineering-Liberal Arts and Sciences Program is that it allows the university to tailor the student for the particular type of engineer society is seeking.

Perhaps this is the program that "will teach the engineering student to develop a sense of the esthetic that goes beyond mere efficiency."

Problem

Education For Empathy

by John Pauly

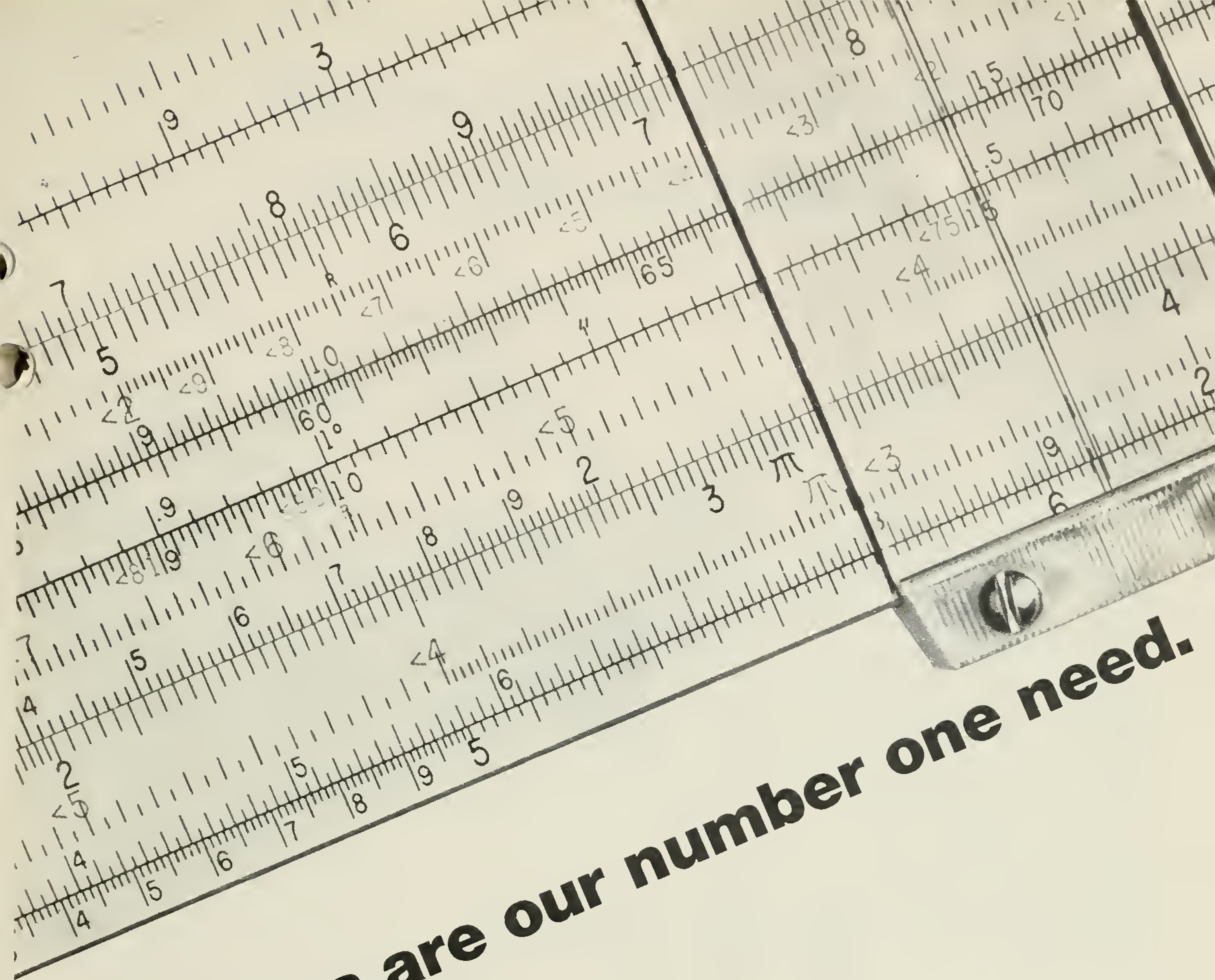
Since this issue primarily deals with engineering education, the idea of interviewing Dean Emeritus Everitt occurred to us. During his term in office Everitt probably accomplished more in the interests of educational reform than any other single person in the College. Although students may not have always agreed with his ideas, few would ever claim that avenues for discussion were closed or that the Dean was unsympathetic toward their suggestions.

In view of his past involvement in the field of education, we asked Dean Everitt about his concept of engineering education in the future. What should the goals of the College be in the coming decade? Dean Everitt felt that the chief duty of the College must be the preparation of engineers for their future jobs. The demands of these jobs, however, would impose new demands on education. Because of the interrelationship of large systems--for example, the economy and ecological systems--the engineers of the future will have to be sufficiently perceptive to understand the interaction of these broad, complex systems. The Dean expressed specific concern about problems of the environment because the solutions to these problems present such tremendous challenges to engineers. In particular the Dean mentioned the problem of overpopulation. The engineer holds a great stake in providing mankind with the means of living together amicably. Dean Everitt has a favorite term which he uses to describe the human factors involved in engineering problems --empathy. Empathy, he says, means, "Doing unto others as thy would have done unto them." Such a concept implies an understanding of the diverse faces of the world community and a respect for cultures different from our own.

Dean Everitt

Thus engineering must be "not merely a learned but a learning profession." The immense responsibilities of the engineer demand that the learning process be lifelong, not merely a four-year encounter. And the educational process must impress this fact upon students; graduates should be well aware of the highly professional nature of the tasks before them.

We then asked Dean Everitt about the feasibility of engineers becoming more involved in politics, since the solutions to so many modern problems depend heavily on political influences. He responded that all



engineers should learn to effectively communicate their ideas in order to exert greater power in the decision-making processes with which they will be directly concerned. As far as actual political involvement is concerned, Dean Everitt felt that the very nature of the engineering profession argues against such involvement. During the time that an engineer serves in a political office, a lapse in his professional career occurs. The lack of continuous professional contact during this period places the engineer at a disadvantage when he returns to his career after leaving politics. In fact, the situation of an engineer closely parallels that of a doctor. Since their political experiences will have little or no carryover value for their professional career, they gain nothing to offset the disadvantage of an interrupted professional career. In view of the great competition for jobs in many companies, many engineers fear leaving their present situation in exchange for a career offering uncertain opportunities and definite liabilities.

During his term in office, Everitt involved students extensively in the educational process. He still believes that movement in this direction is both feasible and desirable. He does not, however, agree with the student activist movement as it has come to exist. He finds the protesters are often too strident in their criticism and do not listen to other viewpoints. Although he agrees with some of the goals of such movements, Everitt feels that such tactics antagonize rather than influence people. The purpose of any sort of discussion should be to persuade people to accept one's point of view. Tactics that antagonize people work against this cause. In view of the many trends toward peaceful, persuasive action--the Movement for a New Congress and political canvassing, for example--it seems that a sizable number of students have come to share Dean Everitt's views on this matter.

In connection with the question of political involvement, we asked him for an opinion about why so few engineers become involved in campus politics. The Dean asserted that the qualities exhibited by student activism in general appeared in local campus politics. He felt that the general disorganization of such politics did not offer the engineers what they were seeking and that the engineers would rather simply study than engage in an activity which appears to offer so little to them.

Some students might disagree with a few of Dean Everitt's views on the subjects we discussed. But it seems that the conflict of opinion in this case matters much less than the man's attitudes. Dean Everitt never assumes the attitude of a bureaucrat. In discussions with the Dean, students do not feel as though the Dean is being condescending or simply trying to pacify them. Any discussion always involves two equals presenting their opinions in a calm, logical manner. Although many complex factors have made such peaceful confrontations rare, and sometimes impossible, students talking with Dean Everitt feel that they have a chance of persuading the Dean to their opinion. They are not buried with a volley of "I agree in theory, but. . .," vague answers. As a result the student gets the impression that if all people in power were as open-minded and helpful, students would find less reason to be so vociferous in expressing their opinions.

Fairness, sincerity that does not have one eye on public image, and a willingness to change his mind--these are the qualities which mark the capable administrators. And the characteristics that will continue to distinguish Dean Emeritus William Everitt of the College of Engineering.

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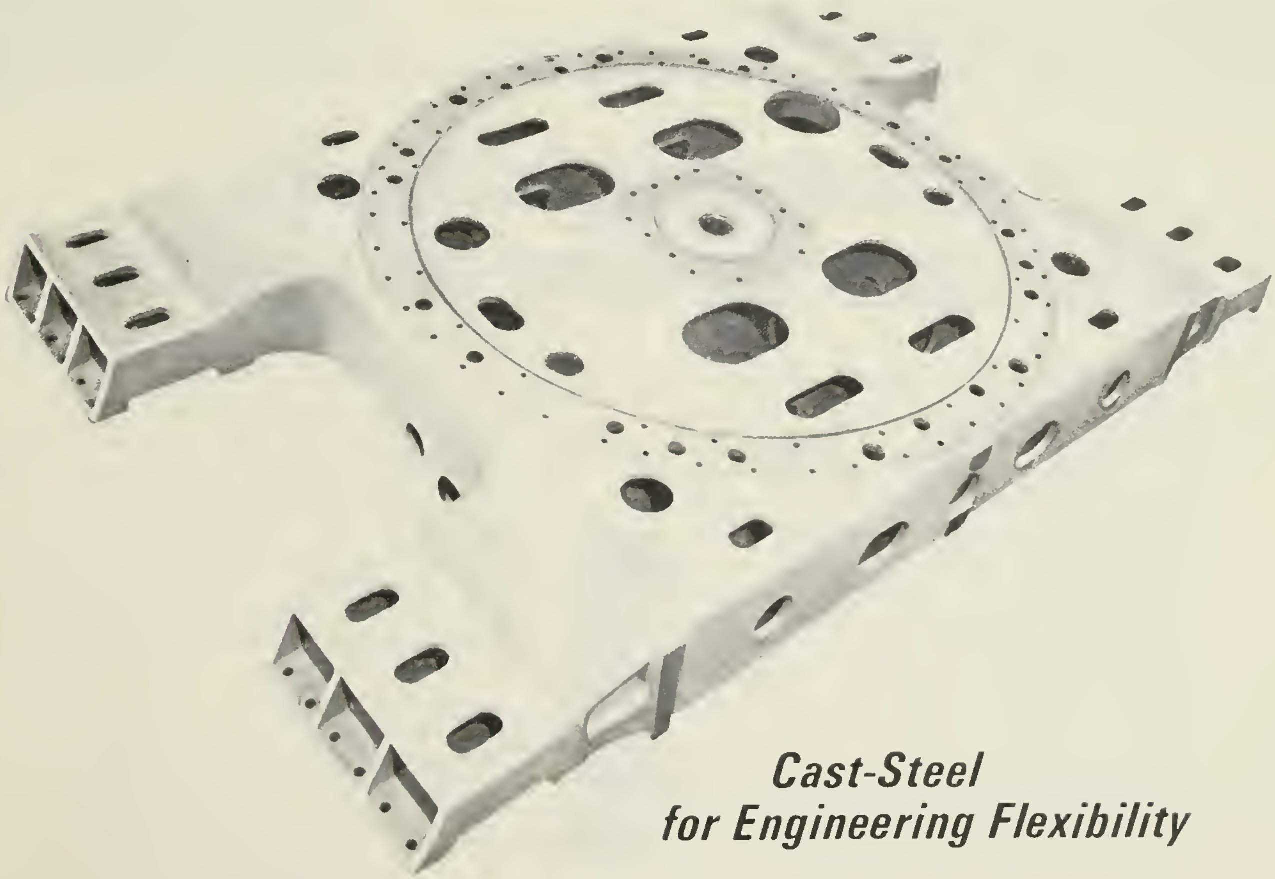

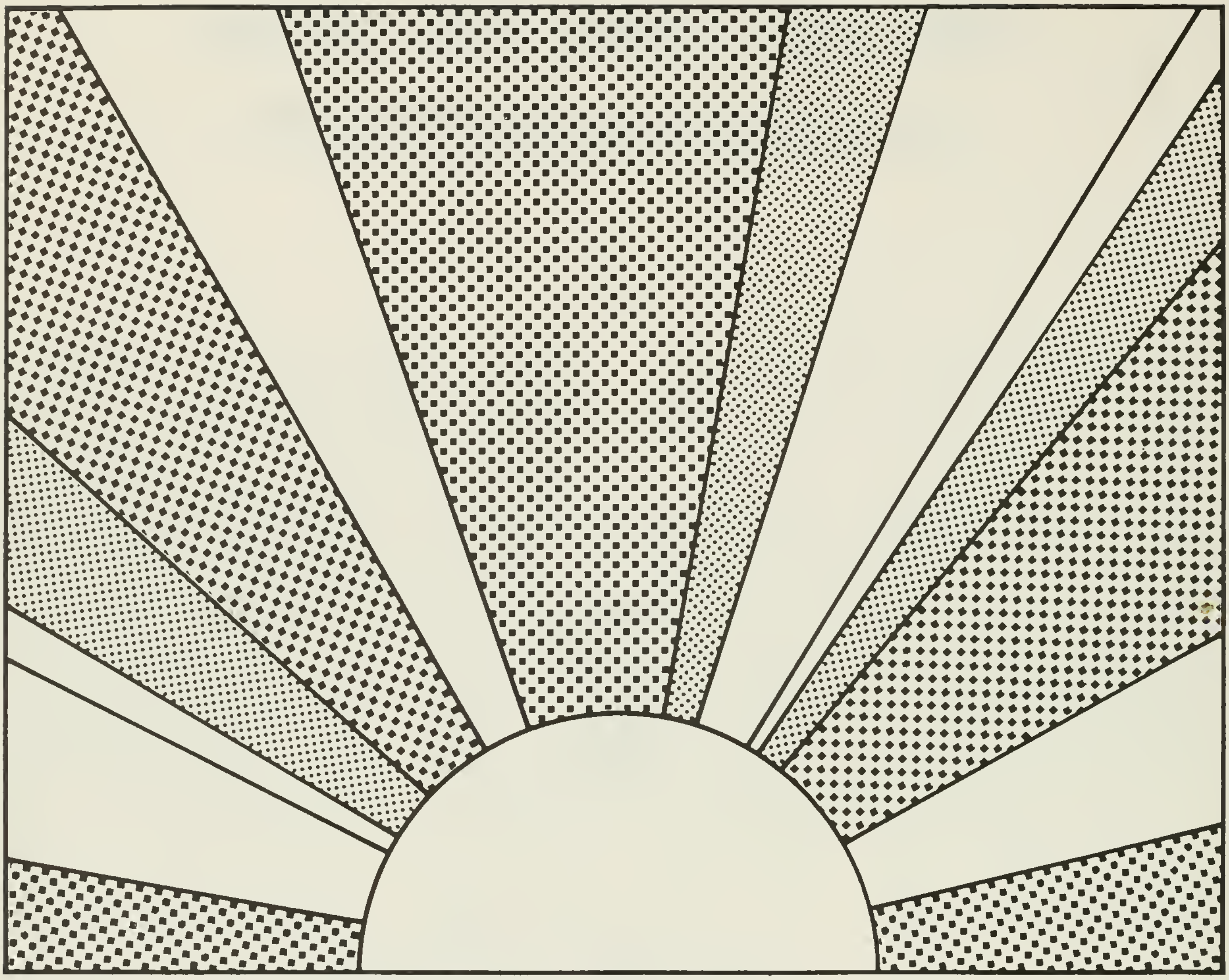

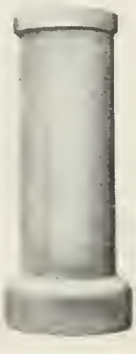

WRITE-IN

The editor encourages everyone to participate in writing this feature.

There once was a popular, daytime television show called "Queen for a Day". During this show some deserving woman was elected queen; crowned, robed, sceptered, and granted one wish. Apparently the Engineering College decided to institute a similar program for the professors in the College. Every year a different professor is culled to serve as a revolving assistant dean for the year. This program of a revolving dean could well be called "Dean for a Year". The lucky professor this year is Dr. Frank Morrison of the Mechanical Engineering Department.

What do you suppose the "Chosen One" is like? Do you imagine that he is about 54 years old, a little overweight, wears a bow tie, has iron-tinted hair (which he keeps slicked back from the middle of his head), and has been an engineering research professor here for 30 years? Do you see an impersonally friendly bureaucrat who is busy manipulating the lives of the students and faculty with his near-absolute power? Well if this is your preconception of the new dean, then your imagination has led you far from the truth.

Dean Morrison is a surprisingly young looking man, considering his position. With his youthful countenance, almost long blond hair, and easy manner, he might well be a teaching assistant rather than a professor and a dean. Since this is his fourth year as a professor here, he is new enough at the game to be fresh, but experienced enough to know what, where, how and why. He has a knack of combining a personal relaxed air with his efficient, professional handling of matters so as to leave a distant impression of competency, even though the tasks of an assistant dean are new to him.

His youth could be an asset for him. It should be easier for a student to ask for counseling from a man who appeared to be more of an older brother than one who might be old enough to be his father. Furthermore, a young dean is not as removed from his own school days as an older dean might be. He therefore might find it easier to sympathize and identify with the students.

In his present capacity Dr. Morrison must lead something of a Jekyll and Hyde life. While the sun rises he is Dean Morrison of 101 Engineering Hall, but after the sun has passed its zenith he changes hats, reverting to his former self, Professor Morrison of Mechanical Engineering, for the duration of the day. Despite the demands that working as a dean make upon him, Dean Morrison professes to enjoy, and appears to be rather enthused with, his new double duties.

A surprising fact that one learns in talking to Dean Morrison is the limited scope of the work of the assistant deans. Power in the university does not ascend hierarchically, with each rung having complete power over all those lower. The power is highly fragmented and the assistant deans have only small portions of it. Instructors control grades. Course content is determined by professors.

David May

Dean For A Year: Dr. Frank Morrison

by David May

Course offerings and curricular plans of study are prepared by the departments. The University and its individual College Deans enunciate basic policy. For example, decisions to accept defense contracts, such as the Illiac IV agreement, are matters of university policy upon which an assistant dean has very little or no say. Excepting a few weak holds on students, the only powers given to the office of the assistant dean lie in an advisory capacity. The opinions of the deans are sometimes requested, deans are invited to participate at meetings, and they are listened to by certain people who do have power in the university.

Though the assistant deans have little power in the University, they can loom large in the world of the individual student. This makes them ideal for advising and counseling. Dean Morrison said that his primary function as dean is to help students. And this should always be the primary and overriding concern of a dean.

Besides personal work for students, an assistant dean also undertakes studies and attends meetings. The studies are an attempt to provide answers to questions concerning general patterns of behavior of engineering students, such as why so many engineering students transfer to LAS. Through these studies the deans hope to better understand students and thereby be able to assist them. The purpose of the meetings is to co-ordinate and inform the deans. Examples of such meetings are admissions meetings and occasional meetings of the deans. The attendance of the assistant deans at such meetings is vital. An assistant dean who is not aware of the latest information is of little value to the students he serves.

Graduation requirements and grades are not within Dean Morrison's control, but they are within his sphere of interest. Concerning engineering course requirements, he advocates a balanced engineering curriculum, including both technical courses and the humanities and social sciences. His beliefs have been bolstered by conversations with representatives of industry who express a desire for their employees to have their specialized technical studies based upon a strong, general background. Grades, he feels, should be left to the judgment of the teacher. An attempt by the College to impose absolute grading standards would, in his view, be an abridgment of academic freedom. He is willing, however, to provide such grading information as he can to students who feel displeased with the current grading situation. As a source of information concerning the student's response to alleged capricious grading, a dean is quite competent.

Dean Morrison will be available to see students all year. His basic purpose is to help students. There is only one catch--if you need help you have to go to him. Without your initiative he cannot do you a bit of good.

Photography by W. Eugene Smith.

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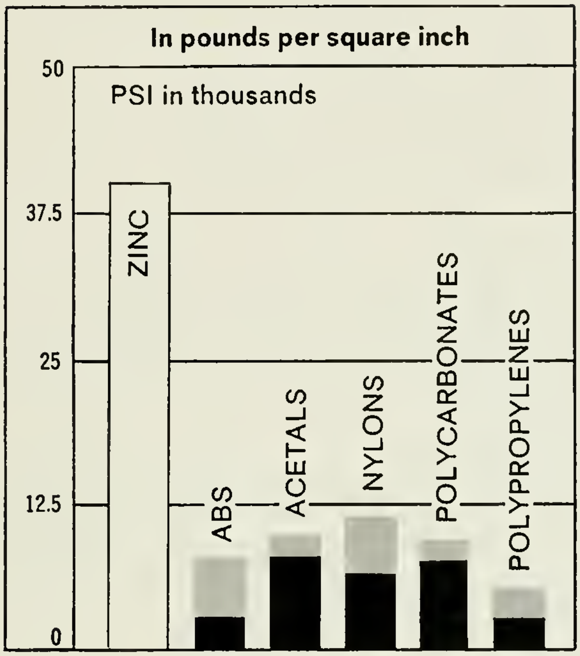
BASIC DESIGN DATA—Zinc Die Castings vs. Plastics

Tensile Strength



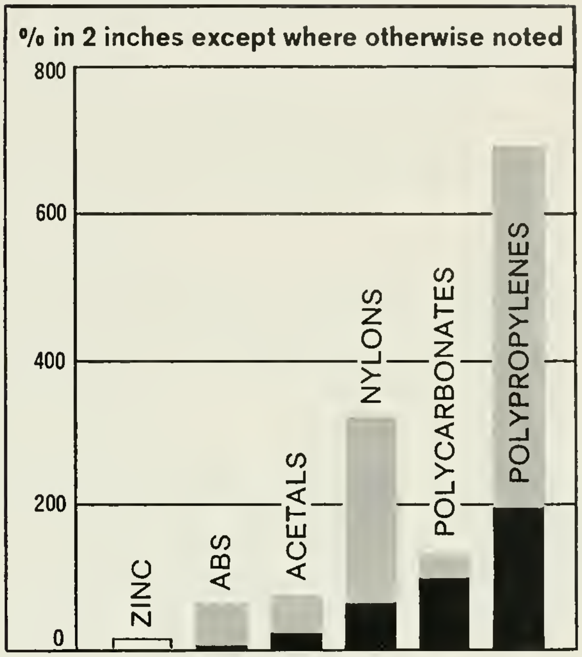
ZINC DIE CASTINGS	TENSILE STRENGTH—psi	
	As Cast	After 20 yrs.
Alloy SAE903, ASTM AG40A, No. 3	41,000(1)	32,000(2)

Source (1) ASTM B86 (2) Reports of ASTM Comm.

SOME PLASTICS USED FOR INJECTION MOLDING	TENSILE STRENGTH(3)—psi	
	As Molded	After 20 yrs.
ABS { High Impact, High Heat Resistant, Medium Impact	3,500- 8,800	Not Available
ACETALS { Homopolymer, Copolymer	8,800-10,000	Not Available
NYLON (Type 6, 6/6, 6/10)	7,000-12,400	Not Available
POLYCARBONATE (Unfilled)	8,000- 9,500	Not Available
POLYPROPYLENES (Unmodified Copolymer)	2,900- 5,500	Not Available

Source (3) Modern Plastics Encyclopedia- 1969-70

Elongation



ZINC DIE CASTINGS	% ELONGATION 2 in.	
	As Cast(1)	After 20 yrs.(2)
Alloy SAE903, ASTM AG40A, No. 3	10	14

Source (1) ASTM B86 (2) Reports of ASTM Comm.

SOME PLASTICS USED FOR INJECTION MOLDING	% ELONGATION 2 in.	
	As Molded(3)	After 20 yrs.
ABS { High Impact, High Heat Resistant, Medium Impact	3—60	Not Available
ACETALS { Homopolymer, Copolymer	25—75	Not Available
NYLON (Type 6, 6/6, 6/10)	60—330	Not Available
POLYCARBONATE (Unfilled)	100—130	Not Available
POLYPROPYLENES (Unmodified Copolymer)	200—700	Not Available

Source (3) Modern Plastics Encyclopedia- 1969-70

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TECHNOGRAPH

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COVER

TECHNOGRAPH

John Mendenhall depicts the Technograph's well-engineered birthday cake.

You're an engineer. You want to do things—big things. What kind of career could you choose at Bethlehem Steel?

Well, you could go into steel plant operations. Here you might supervise operations of one of our ultra-modern rolling mills, or basic oxygen furnace departments. You might design new mills, or direct their construction. You might be responsible for repair and maintenance of colossal, complex facilities.

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Diverse? You bet! We'd be hard-put to think of an industry that can equal steel in the variety of opportunities for engineers and other technical graduates—or a steel company that can match the opportunities at Bethlehem Steel for moving up in management.

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BETHLEHEM STEEL

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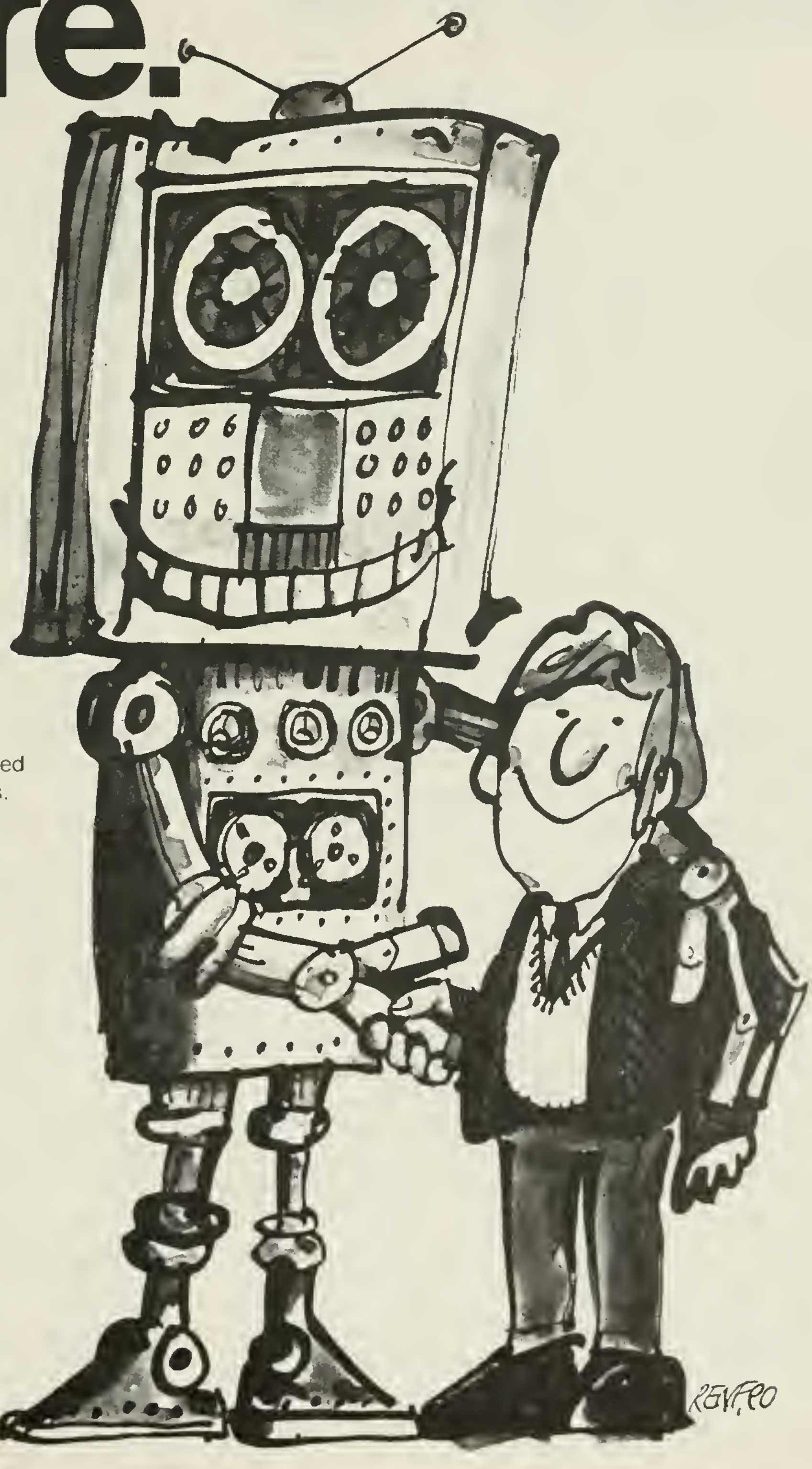

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The practical talents of the computer may be blinding you to its real function—the extension of the human brain.

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EDITORIAL

Thoughts Out of Place

by Armin Elmendorf '14
reprinted from January, 1914

Poets often write verses on the two souls in man, the sensuous and the psychical, the one in continual conflict with the other. Corresponding to these two antagonistic souls or conflicting impulses there are two types of success the one spelled $ucce$$ which provides a *good living* for the victor, while the other brings no physical comforts or delights but wealth of mind. Serenity, dignity, and composure mark the victor. Not power so much over others as power over oneself, not strength to coerce but strength to persuade, not external grandeur but internal splendor are the fruits of victory to him who make a success of *life*. Education for a life should be our quest at college.

What constitutes life? We will say variety of experience and depth of feeling whether of pain or pleasure, delight or depression, and the products of a divine call to create and to rise certify to a full life. An expression of the feeling in art for the quickening of aspiring souls; a comprehensive generalization or law of science to quench the thirst for knowledge of those who wish to know causes and to trace the harmony in nature; a bridge, a canal, a locomotive to facilitate exchange remain as results to crown such a life.

Unfortunately, few such results follow the quest for wealth only. Nor does a rich man often appreciate the real feelings that bring forth these results. The commanding financier may own vast halls of art, but he seldom experiences the depth of feeling which existed in the hearts of the sculptors and painters who wrought the works on exhibition there. The humble poet or painter entering the halls receives the messages that the paintings and statues convey. He really owns the picture of the statue because the essence of the work is his. He it is who is thrilled with inspiration by a magnificent Apollo or moved to compassion by a groping Blind Flower Girl. The materialistic owner may claim the canvas and the paint upon it and the marble, but unless he is capable of receiving the feelings of the artist, the *painting* or the *statue* is not his. Not to own but to enjoy should be our aim.

Culture, as much if not more than training for a living only, should be our quest in college. We owe it to ourselves. This does not mean that we shall become effeminate dilettantes. There is nothing effeminate in the man who lives completely. Refinement in place of coarse and cold might does not signify weakness. Wealth and variety of experience, a broad and sympathetic appreciation of the problems of human life denote manhood of a loftier type than that exhibited by the greedy ambitious aspirant for worldly rank.

Here at the University the opportunity for the development of a deeper appreciation of the fundamental in life, the beautiful and true is open to us. Even as engineers we are not excluded from this sacred privilege. There are many Sunday afternoons, many hours between classes that can be spent in quiet library corners. A consideration of every action with the question, "Is it worth while?" will reveal hours uselessly spent in idle talk, card playing, or at vaudeville performances. The busiest man is usually he who has most spare moments for reading. We are not beyond Poor Richard's maxims. "Be ashamed to catch thyself idle" may be looked upon with a haughty superior air as applicable to grammar school children, but a neglect of its dictum will track us down as well as them. Every day has twenty-four hours of which one-fourth of one hour daily applied to a search for the true and beautiful scattered as gems throughout the world of good literature will add a wealth to life that cannot be purchased by money or rank. Association with great minds is pervasive in its efforts, permeating us with great thoughts. A yearning to rise to their level grasps us and any spark of greatness that may be in us is fanned until it glows. Time spent with them is time spent to the best advantage.

To live as the great men have lived, the authors, scientists, and engineers should be our aim. To aid in the adjustment of an everchanging society, to study its problems and to charge with the reformer into the thick of injustice is a worthy ideal. To feel as the poet and to be able to rejoice in his visions, to think as the philosopher and to be able to travel with him in his journeys of the intellect are powers that can be cultivated at college. To the degree that we participate in these activities do we really live. Education that guides to such a life is true education.

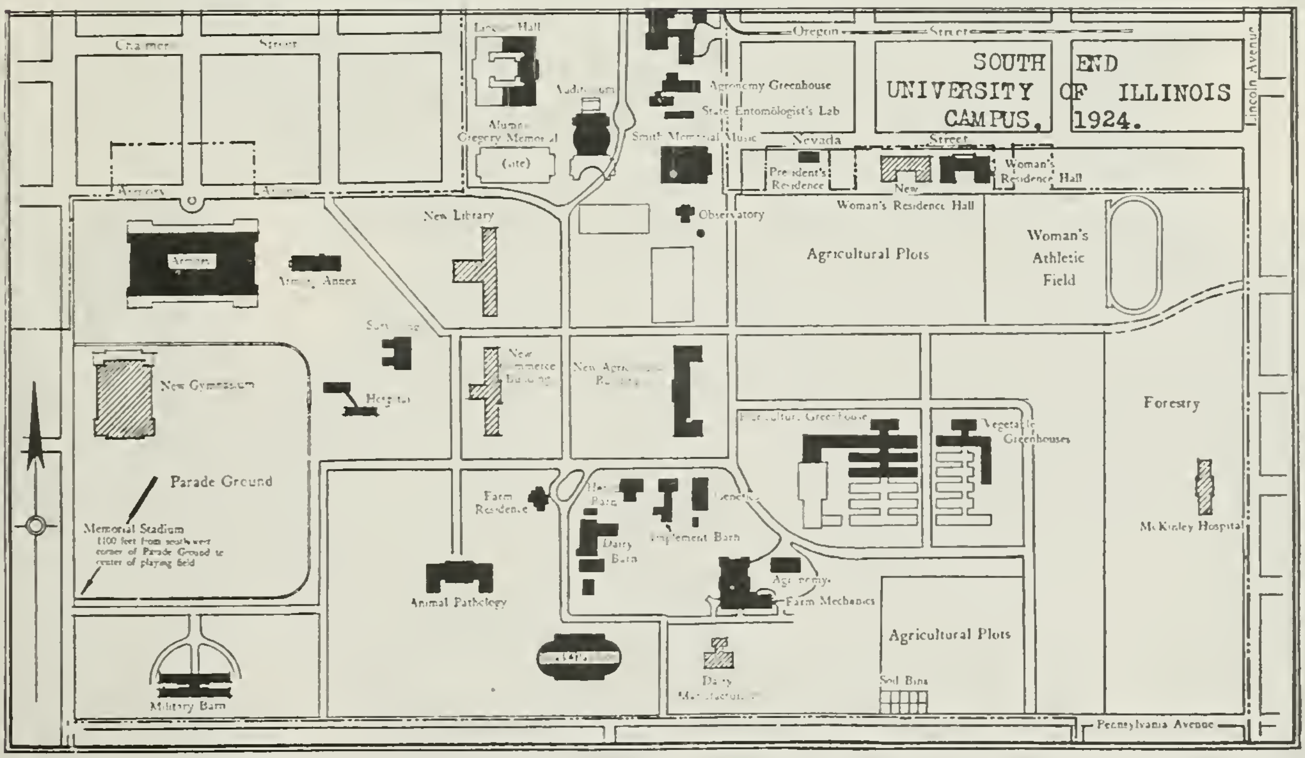
Engineers and Politics

by Sheldon H. Altman '62
reprinted from November, 1961

It seems in the highly idealistic atmosphere often surrounding a university, firm thoughts and actions should result. The supposed intellectual leaders, both in the student body and faculty should be a bulwark representing a solid block supporting American ideals. This unfortunately is not the case. Look about the campus. See who speaks for the students in subjects as serious as politics. It is often some seedy-looking, sneaker clad, predictably unkempt personage defiling any firm stand against spreading communism, accusing the U. S. of forcing the reds into their filthy contamination of the world's atmosphere, defending that bearded idiot 90 miles off Key West, laughing at the current interest in civil defense against possible (very possible) red aggression. Where is their opposition? Who will confront these "Americans" who have read Marx but never have looked at what Jefferson, Adams, Lincoln or wise old Ben had to say. Certainly someone out there still believes in the ideals which have made America so strong, yet so naive; fierce when necessary, but too often goodnatured; independent, yet so sensitive to world opinion.

Can we afford to have to have forty years of Russian deceit, forty years of Communist duplicity, forty years of lies, and back-stabbing defended? Can we let this go unchallenged? Can we watch Communist imperialists change history from day to day and not become angered? Can we compromise ideals which place the individual above the state, which recognize a basic human dignity, which guarantee inalienable rights of life, liberty and the pursuit of happiness? Do you think this is becoming maudlin? Are you asking yourself what this has to do with engineering? Or, why even bring it up?

You, an engineer, mathematician, or scientist, may be the key to America's continued greatness. Obviously the technically orientated person will help to defend his country. It is natural to him. He is a part of a driving, dynamic economy and expanding technology. But what else is he? He is an objective thinker. He can't be fooled by promises of Utopian bliss. He is not satisfied with just feeding his stomach. Here is a man who is capable of the solution of many trying problems. Put this to use. It is time for engineers and scientists to take a more active part in politics on all levels. Read the works of our forefathers. Then read Marx and Lenin and Mao Tse-tung and see what these despots have proposed for us. Get angry. Let's hear your voice.



Photography by W. Eugene Smith.

Our Attitude Towards Military Training

by Don Johnstone '31
reprinted from December, 1930

The perennial controversy between youthful militarists and pacifists is once more in full bloom. And as usual most of the controversy is quite beside the point. The pacifist is almost always far too ideal; the militarist too narrow-minded and imperialistic. The real issue, however, is more personal than either of these two classes would have us believe.

Among things we have picked up in four years of college is the realization that few wars right wrongs, that victory *is* on the side of might, and that most wars could have been avoided by the use of a little more intelligence at the right time. And from a dozen films we have seen that while the *dolce* part of the *pro patria mori* phrase might have been applicable in the days of knightly combat it is hopelessly inapplicable today, where the enemy is not one against whom one can match one's skill, but only a blind piece of shrapnel which will tear off the leg or rip the chest of a mighty fighter and a trembling coward with equal ease. Most of us are faily glad to be alive, too, and recall that a good many years ago Solomon made a remark about live dogs and dead lions.

Another thought that is hard to shake off is the conceit (which in technically trained men can hardly be called conceit) that we are worth more to our homes and the world when we are excavating for a building than when we are digging a hole to dodge bullets in. We remember that 19-year-old scientist who fell on the eastern front during the war--he had already learned more about molecular structure than had ever been known before--and wonder if he might not have contributed to a far greater degree to the peace and safety and comfort of the world if his government had used one iota of common sense and sent him back to his laboratory instead of giving him a gun.

And now, as the legions of irate cadets mass for attack on our editorial strong point, we hasten to assure them that no warfare is necessary. Nobody but a fool thinks that wars have been relegated to the past. Nobody, *including* the fools, thinks that any government will ever use any sense after a war is declared. And since the world we live in, rather than the world we might *like* to live in, is the one with which we have to deal, the fact remains that each of us may find himself some day involved in war.

It behooves us, then, to be as well prepared for that eventuality as possible. From either a national or a cosmopolitan viewpoint, a short war is a good war. And a short war means adequate preparedness-- trained men who can spring into action at the first call; trained *technical* men, who can put their engineering to this emergency use; trained leaders, who can not only do things themselves but can guide others in the doing of them. This in turn means only one thing; military training in the universities.For it is in the universities that the best leaders can be found, and it is during the university period of life that these leaders have the most time to devote to this training.

Dwellers in bottom-lands risk occasional inundations in exchange for the great returns on the fertile lands they cultivate; they have learned that building themselves flood protection systems is more profitable than running away. Just so, a great nation cultivating its colonies and its foreign commerce runs the risk of occasional wars; and here an adequate war-protection system is of more value than retirement in times of crises.

On with the parade!

The Real Co-op Is Your Bookstore

by J. O. Ephgrave '27
reprinted from November, 1926

There are quite a number of people in the College of Engineering, and in all of the other schools, too, who do not realize the truth of the above statement. But it is actually true; the store is owned by more than 4,000 students, each one having just one dollar invested and each one sharing, by virtue of his investment, the profits of the store. This investment is known as membership in the Engineer's Co-operative Society, and is open to any student, whether he be in the engineering school or not. In fact, 45 percent of the members are in colleges other than engineering, and only 18 per cent of the textbook business is done by engineers. Members are responsible for about 45 per cent of the entire business of the store.

The student's part in the organization is as follows: Any student or faculty member may deposit one dollar, which enrolls him as a member of the store. For every purchase that he makes he is given a receipt which he signs and deposits in a box in the store. These receipts are assorted periodically and each member is given credit for the amount he has purchased on his record card. The total purchases are computed at the end of the year and dividends are paid, based on the total volume of business done and the net profit. The amount of the dividend is decided upon each year by the Board of Directors. The student may withdraw his membership at any time he sees fit, but if it is taken out before August 31 of any year he has automatically given up his claim to dividends due him on purchases for that year. An exception to this part of the constitution is made in the case of seniors; their dividends and membership refund is given them just before graduation in June.

The policies of the store are determined by a Board of Directors, consisting of two members from each of the campus engineering societies. A sophomore is elected from each society each year and holds office during his junior and senior years. There is also a faculty advisory board consisting of Dean H. H. Jordan, Professor A. R. Knight, and Professor W. M. Wilson, all of the faculty of the College of Engineering. All matters brought up before the Board are referred to the faculty board for approval.

The Society was organized in the spring of 1921, and a store which carried engineering supplies was started. From the very first day the store was successful, in spite of severe criticism that such an organization had no place on the campus and could not live. After a year of business the selling space was more than doubled, books and supplies for the entire University were added, and after five years the store has grown beyond the fondest hope of those who started with merely an idea. A full-time manager and ten student assistants are now required to serve the patrons, and the store has grown to the position of one of the important University supply stores.

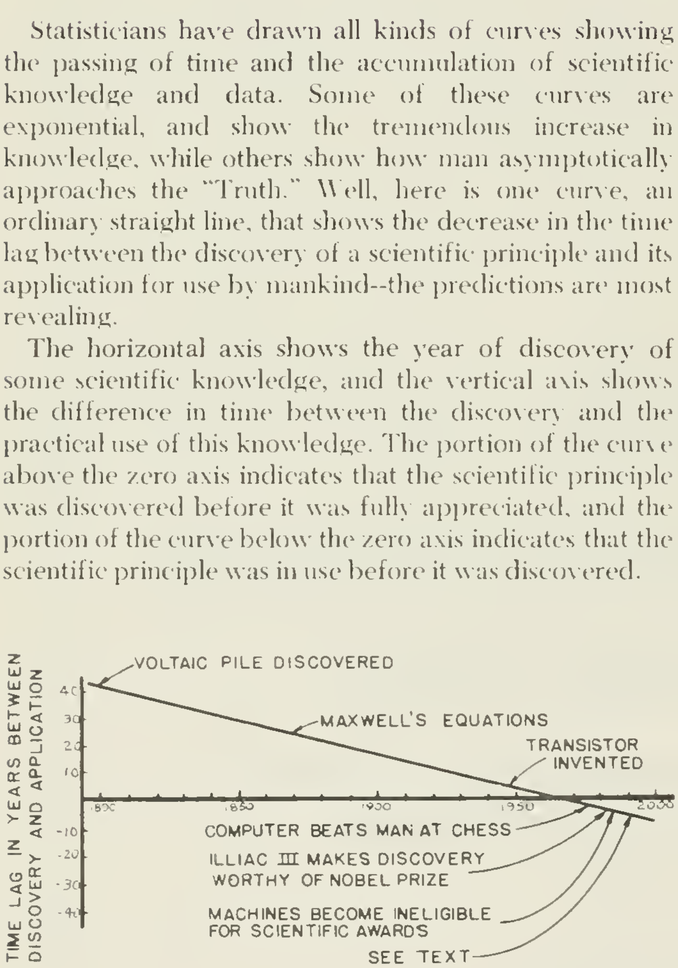
We have written the above editorial because we believe that there are a large number of engineers, especially freshmen, who are missing an opportunity not only to save themselves money, but to support an engineering project.

Man Against Machine

by Henry S. Magnuski '65
reprinted from December, 1963

Statisticians have drawn all kinds of curves showing the passing of time and the accumulation of scientific knowledge and data. Some of these curves are exponential, and show the tremendous increase in knowledge, while others show how man asymptotically approaches the "Truth." Well, here is one curve, an ordinary straight line, that shows the decrease in the time lag between the discovery of a scientific principle and its application for use by mankind--the predictions are most revealing.

The horizontal axis shows the year of discovery of some scientific knowledge, and the vertical axis shows the difference in time between the discovery and the practical use of this knowledge. The portion of the curve above the zero axis indicates that the scientific principle was discovered before it was fully appreciated, and the portion of the curve below the zero axis indicates that the scientific principle was in use before it was discovered.



This idea may not seem very clear at first, but it will after the following selected points are noted. In 1800, Volta discovered his voltaic pile, an invention which led to the electric battery. A full forty-three years later Morse used this principle to power a telegraph, and Western Union has been making money on that idea ever since. In 1873, Maxwell published his famous equations, predicting the existence of radio waves, and it took Guglielmo Marconi only twenty-three years to prove that Maxwell was right. In 1948, Bardeen and others discovered the "transistor effect." Six years later engineers developed the transistor radio, and tubes have been dying since. Thus, the time lag between the discovery and use of an invention has decreased as the centuries roll on.

Clearly, as the curve indicates, there must be a time when the delay between discovery and use becomes zero. This time is coming soon, and in fact, it is scheduled for June, 1966. On a morning in that June, some young, bright physicist is going to walk out of his lab with a brand new scientific concept in his mind, and find someone selling an application of the idea on the very same day. When this happens, the curve will have crossed zero, and we'll be in an era where we build and use things without knowing why they work.

At first this situation won't be too bad or disturbing. The consumer applications divisions of many industries will put a new product on the market, and a month or two later the engineering research department will find out what makes the thing work. As time goes on, however, this delay between the marketing and the completion of research on a new product will become longer, and men will be using things that they built but know absolutely nothing about. For instance, in 1980, some computer will produce a revolutionary theory that will startle the world. It will be used immediately by engineers but it will take a group of scientists a year and a half of tedious hard calculations to prove that the computer is right.

The above rather embarrassing situation, coupled with others like it, will start a revolt against computers brewing in the minds and hearts of scientists. Unfortunately, by this time both scientists and engineers will be relying heavily upon computers, and they wouldn't dare attack their machines right away. As the years go on, however, computers will start beating men at everything, including thinking, playing chess, athletics, and man's age old favorite, sex.

This state of affairs will trigger an open revolt against the machines, and man will do everything nasty he can possibly think of to the computers, including pulling their plugs. Within forty-eight hours the revolt will be over, scientific progress will be set back fifty years, and man will be master of the world once more.

To a man with emphysema, a flight of stairs is Mt. Everest.

If you have emphysema or other chronic lung problems, you know what it's like to climb a flight of stairs. And you probably don't know what it's like to play a round of golf or even take a walk.

Union Carbide's Linde Division has developed a portable liquid oxygen system which many doctors prescribe for their patients.

It weighs less than 9 pounds full. Set the oxygen at the flow your doctor tells you to. And you can do many of the things you did before.

Sure, we've oversimplified the whole thing. We're not going to go on and on about all the Union Carbide technology that makes the Oxygen Walker possible.

It's just one of the things we're doing with air.

We separate and purify nitrogen, argon, neon and krypton for industry. We make liquid nitrogen systems for everything from refrigeration to surgery. We make mixtures for underwater divers.

It makes sense that if we can help a diver dive to 1000 feet, we can give a man with emphysema the air to get to the top of the stairs.

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1971

Technograph Passes Forty-Sixth Birthday

by Matt Wilson '34
reprinted from December, 1931

PROBABLY few people realize that the Technograph, by virtue of having been founded in 1885, is one of the oldest publications on the University of Illinois campus. It was first called *Selected Papers of the Civil Engineers' Club*, and was the official publication of that organization for the first few years of its existence. A note in the first volume tells the purpose of the magazine.

"The Civil Engineers' club of the University of Illinois is essentially an undergraduate society, most of the papers being prepared by students. Not the least important of the results to the members have been the stimulation of independent thought, a development of the ability to hunt up one's own information, and of cultivation of the power to express ideas clearly, concisely, and forcibly.

"This publication is made to place in permanent form some of the papers read at meetings, and also to extend the influence of the society. The intention is to publish a similar volume annually. The committee regrets that the number of illustrations and length of many of the papers precludes their publication, and also that the valuable discussions of the papers have not been preserved."

From a financial standpoint the advertisements in the first issue paid for all expenses, cuts, and left a balance of twenty dollars, which was invested by W. R. Roberts and Lincoln Bush in a bulletin board as a surprise on Prof. Ira O. Baker and Prof. A. N. Talbot.

The first volume contained a number of good papers. Among them were "Hulton's Formula for Normal Wind Pressure," and "Hints to Students on the Education of an Engineer," the latter by Prof. Baker. Prof. Baker stressed the importance of a well-rounded education to an engineer, in addition to his technical training.

The first few volumes of the magazine sold for thirty cents each, and were about the size of a composition book.

The Civil Engineers' club continued to publish *Selected Papers of the Civil Engineers' Club* for four years. During this time the Mechanical Engineering club was organized, and in the spring of 1891 the magazine was published under its present name, *The Technograph*, with the two organizations co-operating in publishing it. Soon after this the Architecture club was organized and joined forces with the first two clubs to put out the magazine. At about this time they increased the price to fifty cents.

The second issue published under the name *Technograph* was of unusual interest because of the illustrations contained in it. Pictures were shown of the present University Hall, with the title, "The College of Engineering." Other pictures showed the machine shop, drawing room, collection of civil engineering instruments, the electrical laboratory, and the heads of the departments.

The eighth volume, published in 1893 contained an architect's drawing of engineering hall, for which the state legislature had just appropriated $160,000. The trustees of the university had asked graduates of the architecture school to compete in the design for the building, and first prize was awarded to G. W. Bullard of Tacoma, Washington, who became architect of the building.

It was not until 1895 that the *Technograph* had an independent staff. It was about this time that *Technograph* articles were favorably noticed by indices of engineering literature. Several articles were reprinted in other engineering magazines, among which Prof. Talbot's railway spiral, now a classic, was probably best known.

In 1896 the *Technograph* became an entirely scientific publication. The following year, however, marked another big change. Each engineering department was given a separate section of its own, for both notes and news. The Association of Engineering Societies was formed, and had charge of the magazine.

The next ten years passed with very few changes in the makeup of the *Technograph*. The magazine contained both articles of purely local interest and articles of engineering value. Successive editors began to bemoan the lack of interest of students in the paper, so a competition between societies for representation on the staff was arranged, and met with some success.

About 1908 general business conditions, similar perhaps to those prevailing today, began to make themselves felt in the *Technograph*, and the financial situation became very precarious. A change of some sort was necessary, and it was thought that the problem might be met by making the magazine a quarterly. However little success was met with, as the first year in which it was supposed to be quarterly only one issue appeared, the next year three, and it was not until 1911-12 that four complete issues were distributed. Throughout this entire period financial problems handicapped the staffs. In 1911 a complete reorganization of the editorial policy allowed the use of articles of more general interest, and broadened every department. The advisory board was also enlarged.

World conditions during the period of the war had their effect on the *Technograph*, and in 1918 publication was suspended. After the return of normal conditions, the magazine was completely reorganized under the direction of G. L. N. Meyers '21. The size was changed from the booklet size to its present dimensions, and the custom of using a different picture on each cover was adopted. In March, 1923 another big step forward was taken when the magazine became affiliated with Engineering College Magazines Associated, an organization which has since grown to include magazines from twenty-three of the foremost engineering colleges in the country. The purpose of this association is to raise the standards of the member magazines. This is accomplished by the adoption of uniform standards of practice, and by cooperation in both business and editorial problems.

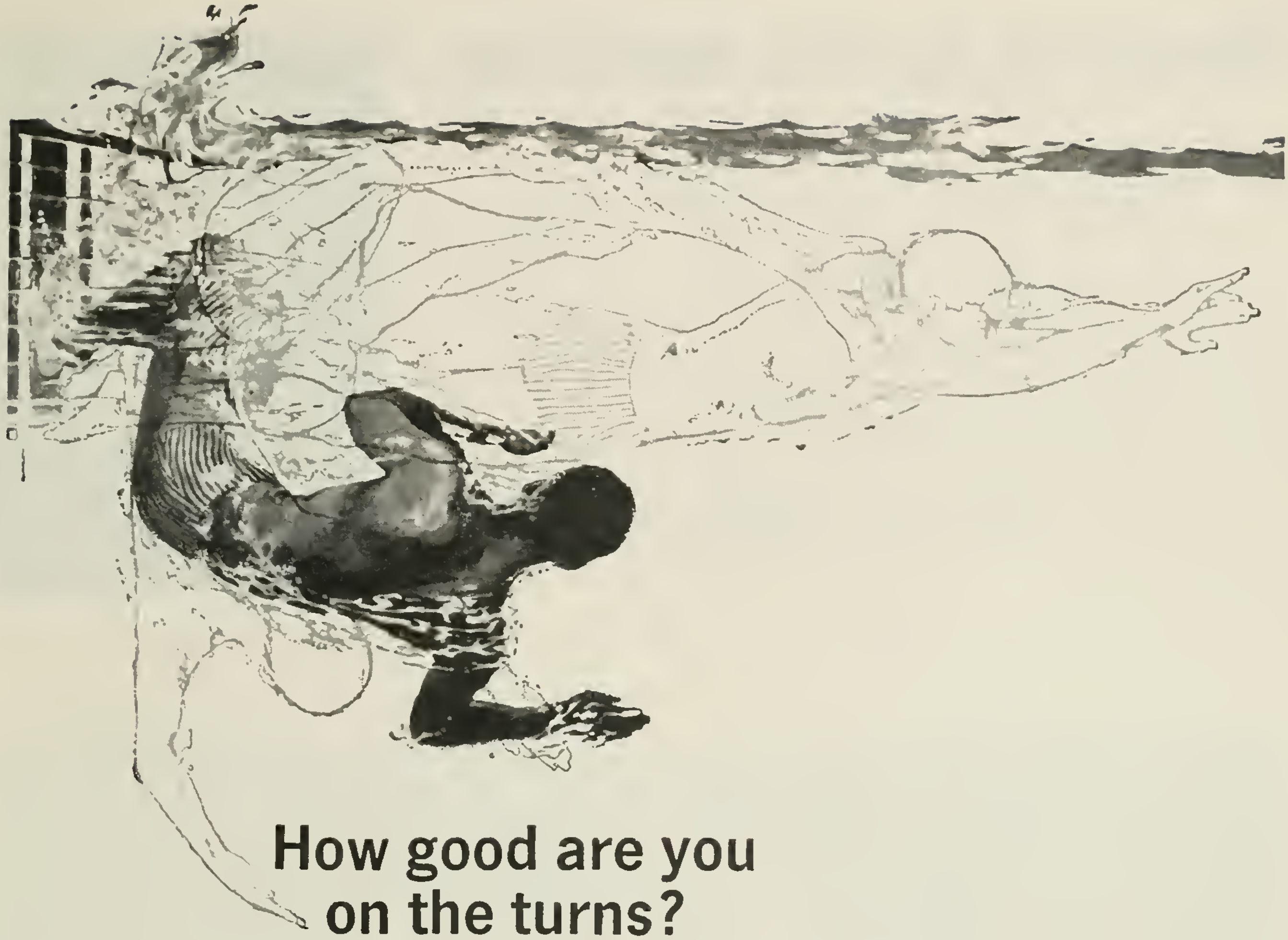
The decade 1920-1930 saw few radical changes in the paper, but a gradual improvement in all departments. Feature articles tended to be of more local interest, as well as of engineering value, and departmental pages were enlarged.

In 1930 another big change was made when the *Technograph* became a monthly publication. During the year 1930-1931 student articles were featured, and more space was given to honorary and professional organizations on the campus. An informally conducted "Know Illinois" campaign was conducted throughout the year, with such features as the engineering library and the Engineering Experiment Station being introduced. A new cover was designed, with a series of pen sketches of ancient engineering masterpieces appearing on successive covers.

Few radical changes have been made this year. The cover was altered only slightly, to include the words "University of Illinois." Modern engineering triumphs are being used as the subject for the cover series. Financial problems are being encountered this year, and have forced the elimination of several improvements that were suggested. The standard of the magazine has been kept up to par, however, as evidenced by the fact that the first two issues of this year were rated as "A" issues by the chairman of the association.

An attempt is being made this year to dress up the inside of the magazine. Readers may notice that this issue is printed on an enamelled paper, a better-appearing and more pleasing paper. New section headings are being designed, and two of them, for the editorial and departmental sections, are included in this issue. The remaining drawings will be ready in time for use in the next issue, in February. In the departmental columns, in addition to the new headings, cuts of the pins and keys of several of the professional organizations have been made, and are used with the notes pertaining to the organizations.

This unusual view of the sundial, with the east tower of University Hall in the background, is familiar to all Illinois engineers



Women Are Not For Engineering

by Dean Eric A. Walker, Dean of Pennsylvania State University, College of Engineering and Architecture
reprinted from November, 1955

Editor's note: This article first appeared in the May issue of the Penn State Engineer. While it does not necessarily reflect the opinion of the staff we feel it is of enough general interest to be reprinted here.

Again, or perhaps I should say still, we are in the midst of a shortage of engineers. Once again the demand far exceeds the supply and once again colleges are reporting that more companies are visiting their campuses than they have graduates eligible for employment. This season, too, also brings a spate of curealls and ready answers to the problem. Some are thoughtless. One which reached my desk suggested all the engineering colleges had to do was to lower their standards, make it easier for a young man to be an engineer, and the shortage would be over.

There is one solution which appears almost annually which deserves more than passing attention. That is the use of women as engineers. Sometimes the argument arises from debates concerning the eligibility of women in honorary societies. Sometimes it is based on the very real accomplishments of the unusual women who have made enviable reputations in the profession. No one can deny there have been successful women engineers. Edith Clark was long an authority on certain phases of transmission of electric power. Lilliam Gilbreth was well known to engineers and business men long before the publication of "Cheaper by the Dozen." There are some good women teachers of engineering. I believe no one can deny that *under certain circumstances* women can have distinguished careers in engineering and make a real contribution to their employers and to the benefit of science and the industrial world.

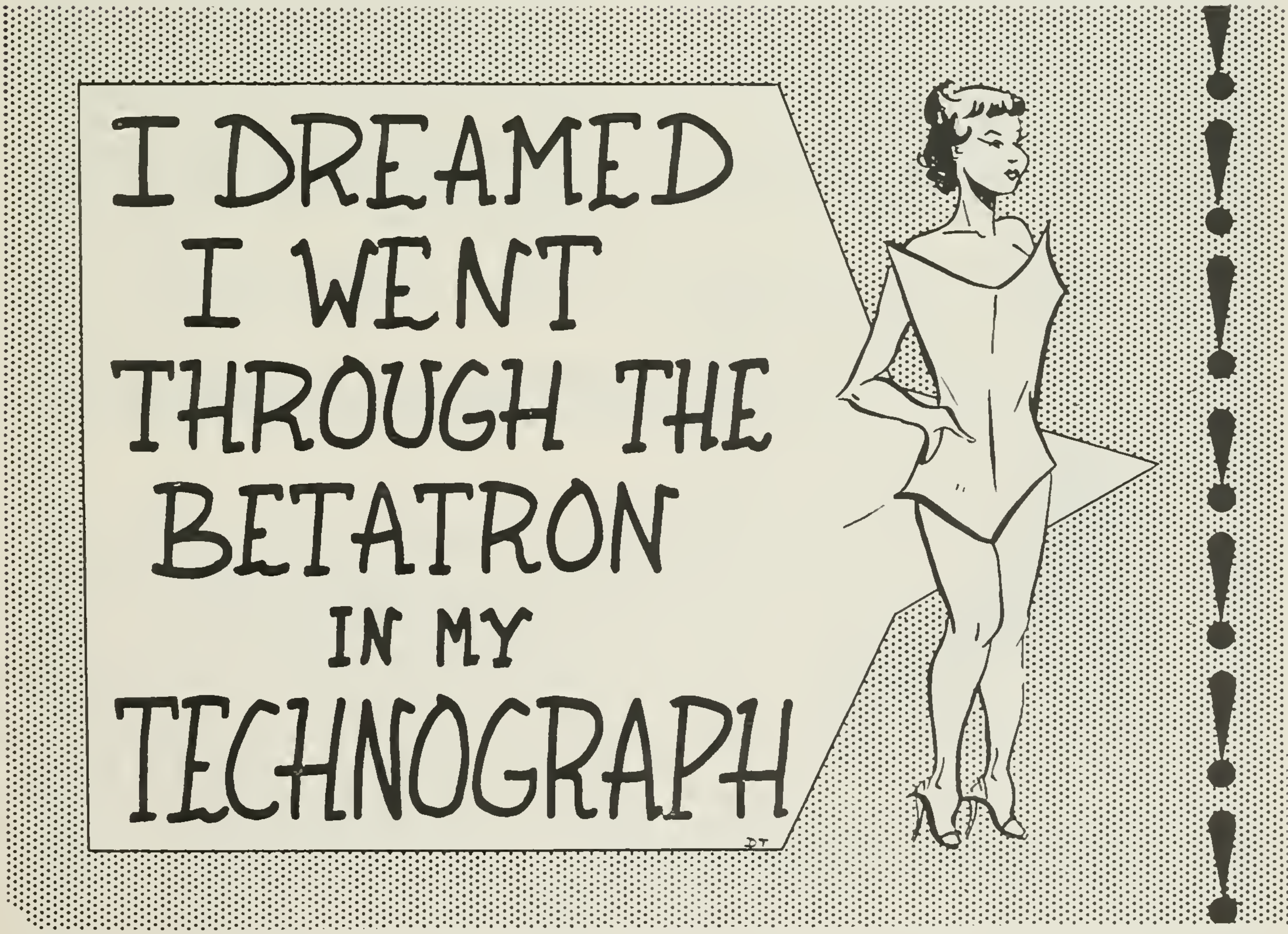
The principal reason that women engineers are not more numerous and that they do not make a more sustained contribution to the profession is that the proper circumstances rarely exist. Let us take a brief look at some of the requirements.

First, an engineering student has to have certain basic capabilities before it is profitable for him (or her) to embark on an engineering education. Without enumerating them, these are more rare in women than in men. Second, he must put in four or five years of extremely hard and demanding work to get his bachelor's degree. This he usually does at his own, his father's, or at public expense. In any event someone has to foot the bill and such bill-payers have less confidence that this is a wise investment for women. Third comes employment by some industrial organization. Years ago an industry might have expected to get an immediate dollar's return for a dollar spent on a neophyte engineer's salary. Except in unusual circumstances this possibility has ceased to exist. Engineering requires a rather long and somewhat indefinite period of training after formal schooling ends. In some companies this training takes the form of a series of courses, often pursued on company time and at company expense, adding up to at least the amount of material and performance standards one expects for conferring a master of science degree. It is fairly obvious that, through this period, even though it extends for one to three years, the company cannot expect to get a fair return for its outlay. At least one company has estimated that it invests $10,000 in each of its engineering recruits before the recruit begins to pay his way. It is my opinion, at least for large technologically-based companies, that this is not far from the average figure. Over a lifetime of work the company expects that money to be returned and more. If the man stays with the company the probability of a direct return is very high. If he leaves the company the return, even through indirect means, is often no less real. One company explains that the engineers who leave its employ are in another job the best salesmen for the company's product.

Now how does this pattern of behavior affect the careers of women? The most evident ambition of many women is to get married and raise a family, and certainly not to pursue a career in engineering. Knowing this, few companies are willing to risk $10,000 on a beautiful blonde female engineer, no matter how good she may be at mathematics or electrical design. The chances of her staying to pay off are just not good enough.

One advocate of engineering as a women's profession has pointed out that these women, properly trained, can return to the profession after they have raised their families and are able to accept full-time employment. Now what sort of engineers would they be after ten or twenty years being out of touch with the profession? An engineer working full time at the job has difficulty enough in staying abreast of new developments.

However, it is still true that many women with training in science, mathematics, chemistry, etc., can find employment in the engineering profession as engineering aides to assist with testing, construction, mechanical layout, etc. These are jobs, which must be done in solving an engineering problem, and they do not require a full-fledged professional engineer to do them. In short, no one can say that engineering is not for women. It is usually the other way around--women are not for engineering.



Clippings

Underhanded Recruiting Techniques Condemned

Some industrial recruiting practices bring a sharp warning from the National Industrial Conference Board that such tactics may backfire and prove disasterous to the companies employing them. And, it is noted, "the damaging effect they may have on the lives of the students themselves can hardly be overemphasized." In listing the following examples, the NICB says some of them are hard to credit and are not the practices of the vast majority of companies:

1. Adding pay extras for grades above C, for courses with certain professors, for a pleasing personality, and for many other items of similar "importance."
2. Putting the senior on the payroll prior to graduation.
3. Inviting likely candidates to lush weekend parties.
4. Offering a "vacation," expenses paid, before the candidate reports for work.
5. Providing "expense allowances" up to $1,000 to defray costs of moving from the campus to the company.
6. Presenting gifts and bribes in the hope of getting preferential treatment from college placement officers.

Another aspect of recruiting, not necessarily encouraged by industry has been a practice some students employ when visiting prospective employer's plants. Usually, the company pays the student's expenses for his trip from school to the plant (fare from Chicago to New York.) However, several students from various colleges have taken to the practice of visiting several industries in a particular area and charging each firm the full amount of their trip, rather than averaging the total expense. Some students have received money for three round trips to industries in the same area, when they really made one trip and visited all the plants on this trip. As industries are catching on to this plan, it is politely, but firmly being discouraged.

A survey by Opinion Research Corp., for the AIEE, finds that engineers think their profession is more attractive than it was 10 or 15 years ago, but there is room for improvement in relations with management. The surveyed engineers indicated they are given too much routine work, their pay is not high enough in comparison with others of the same or less ability, and they are not kept informed by company policies. Seventy-one per cent said they disagreed that the individual engineer needs some sort of a union or similar organization to represent him.

Student Uprising

A pre-planned demonstration by student leaders, fulfilled a promise made last year in the Mayor's office on the occasion of the student march last spring.

It was promised last year that the students would again protest if no concrete action were made toward school relocation.

The demonstration began with a funeral procession and mock coffin being carried to the east end of the pier. A short eulogy was given and the coffin slid into the lake carrying with it Mayor Daley's promises for action. The coffin wouldn't break through the ice because as one student put it, "this showed the weakness and shallowness of the promises made by the Mayor."

After this loud but orderly procession about 30 cars proceeded in a solemn line to Garfield Park, one of the proposed locations, and a cornerstone was laid. It read: "Let it be known that we, the students of the University of Illinois at Chicago do hereby claim this land for a new UIC site on the 10th day of March, Anno Domini, 1960."

The press coverage included all the Chicago dailies. "Newsweek Magazine" and NBC and CBS news commentators.

Why There Are So Few Lady Engineers

The University of Texas reports that for the first time in 20 years a woman has been granted permission to enroll in the civil engineering department. There are two reasons for this. First, the clothing worn by the women, and second, the bashfulness of the instructors. As an explanation of this the following story is told. In 1905, two girls were enrolled in the department. They took a hiking trip with the instruments, but somehow the instruments would not work correctly when the girls were near them. The instructor said he had often heard of girls having magnetism, but surely not enough to affect the compass needle. Further investigation caused the instructor blushingly, to inform the girls that their corset stays were causing the trouble.

The girls in 1926 don't have any effect on the compass needle.

Manhattan's Lightning Rod on the Empire State

All of Manhattan has little to fear regarding lightning storms, now that the Empire State building reaches nearly a quarter of a mile into the sky. It is itself Manhattan's lightning rod. And being well grounded by the massive steel work, the building itself has no further worry from the charged lightning bolts.

Experiments have been carried on with 5,000,000-volt bolts of laboratory lightning in the research department of General Electric, showing that the world's tallest building affords lightning protection to all buildings within a considerable radius of it, with the possible exception of one or two buildings nearby. New York's skyline in miniature was used in the tests, and bolt lightning was thrown earthward. Each time the tower of the Empire State building was touched. No damage resulted, the model itself being well grounded as is the original structure.

This neutral volume is cone shaped, such as would be included by a line drawn from the top of the building to a radius of about a mile high. The protected area plan has already been put to use in the safeguarding of oil storage tanks in the oil fields of Southern California. There tall rods placed near the big oil reservoirs provide overlapping protected areas, thus lessening the possibilities of fire hazards from lightning flashes.

A few weeks after this experiment was conducted, the Empire State building was actually struck three times in a severe electrical storm, to prove again the worthiness of the name, Manhattan's lightning rod.

Paris Builds Downward to Avoid Skyscrapers

Skyscrapers in America may continue to reach for the clouds, but modern Paris relieves congestion by building down into the ground. A network of underground passages for cars, pedestrians and small freight has been proposed by one of the Paris city officials. The project includes the construction of ten miles of tunnels, moving sidewalks and moving freight carriers. Engineers see no difficulty, but the cost would average $2,000,000 per mile. All construction would have to be done below the level of the subways which form a spider's web just below the city's surface.---*The Star.*

This beautiful view of the Boneyard is familiar to all Illini engineers

Printed below are nomination forms for the Everitt Teaching Award and the Stanley H. Pierce Award.

You may nominate any two instructors for the Everitt Teaching Award. For the Pierce Award, please nominate one faculty member and one student who have helped develop closer student-faculty relations within the College.

Both of these forms can be sent through University Mail to Engineering Council, 106 Engineering Hall; or dropped into the ballot boxes in your Department office.

Dean Everitt Teaching Award

Name ____________________

Professor
Graduate Student Department ________

Course ____________________

Name ____________________

Professor
Graduage Student Department ________

Course ____________________

Stanley H. Pierce Award

Faculty Nomination

Name ____________________

Department ____________________

Why do you think this faculty member deserves award?

____

____

Student Nomination

Name ____________________

Department ____________________

Why do you think this student deserves this award?

Our 50 year guarantee on clay pipe was ridiculous.

Our new guarantee is twice as ridiculous.

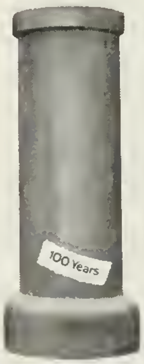
We just raised our 50 year guarantee on the durability of clay pipe to 100 years.* What's so ridiculous about that?

Mainly the fact that guaranteeing clay pipe for any length of time is like guaranteeing the law of gravity. Clay is one of those rare elements in nature that is virtually incapable of being corroded or chemically broken down.

Clay is a residue. It's what is left after sun and rain and sleet and snow have beaten down on the earth for thousands of years. When the earth's crust can't be broken down any further, what you have is clay.

So you can find clay wastewater systems all over the country that have been serving for generations without ever wearing out.

And, we'd like to add that our patented urethane joint makes Dickey coupling pipe the best you can buy. Constant compression, plus flexibility of the plastic material, make certain that a complete bottle-tight seal results throughout the entire joint area. The most dependable and total seal you can get in a wastewater system . . . even if settling occurs.



All of this is why, even though makers of other kinds of pipe never seem to guarantee their product for any specific length of time, we don't hesitate to guarantee ours for 100 years. And that may be the understatement of the century.

W S DICKEY
Clay Manufacturing Company
Kansas City, Missouri; St. Louis, Missouri; Lehigh, Iowa; San Antonio, Texas; Birmingham, Alabama; Meridian, Mississippi; Texarkana, Texas-Arkansas

*Dickey Clay will supply — free of charge — replacements for any clay pipe which has been damaged, destroyed or impaired in service for a period of 100 years from contract date, if damage has been caused by corrosion or other chemical decomposition from acids, alkalis, sewage or industrial wastes (except Hydrofluoric Acid) or damage by rats or other rodents whether pipe is used for industrial, residential or general drainage purposes. Damage from improper handling, placement or trench loading is not covered.

An engineer can cut crime as well as any cop. Maybe better.

Last year, murder was up 7%. Rape was up 17%. Robbery was up 14%.

It's getting to the point where a woman can't show her face on a dark street. And grown men are running scared. Sadly, crime has become a part of our everyday lives.

Where do we turn for help? To police, of course. But why not also to engineers?

Engineers at General Electric set out to develop a more efficient streetlight. And they came up with one of the most efficient crime fighters ever invented.

It's called the Lucalox® lamp. It puts twice as much light on a street as any other lamp without any extra operating cost. And wherever Lucalox has gone up, crime has gone down. By 50% or more in city after city.

But that's not all an engineer can do. He might design communications equipment that enables one patrolman to do the job of two. Or a complex of traffic monitors that puts twenty cops back on the beat. Or even a patrol car to do its special jobs in a better way.

It's sometimes hard for people to realize that engineers, with their technology, can solve social problems. But, in fact, some social problems can't be solved any other way.

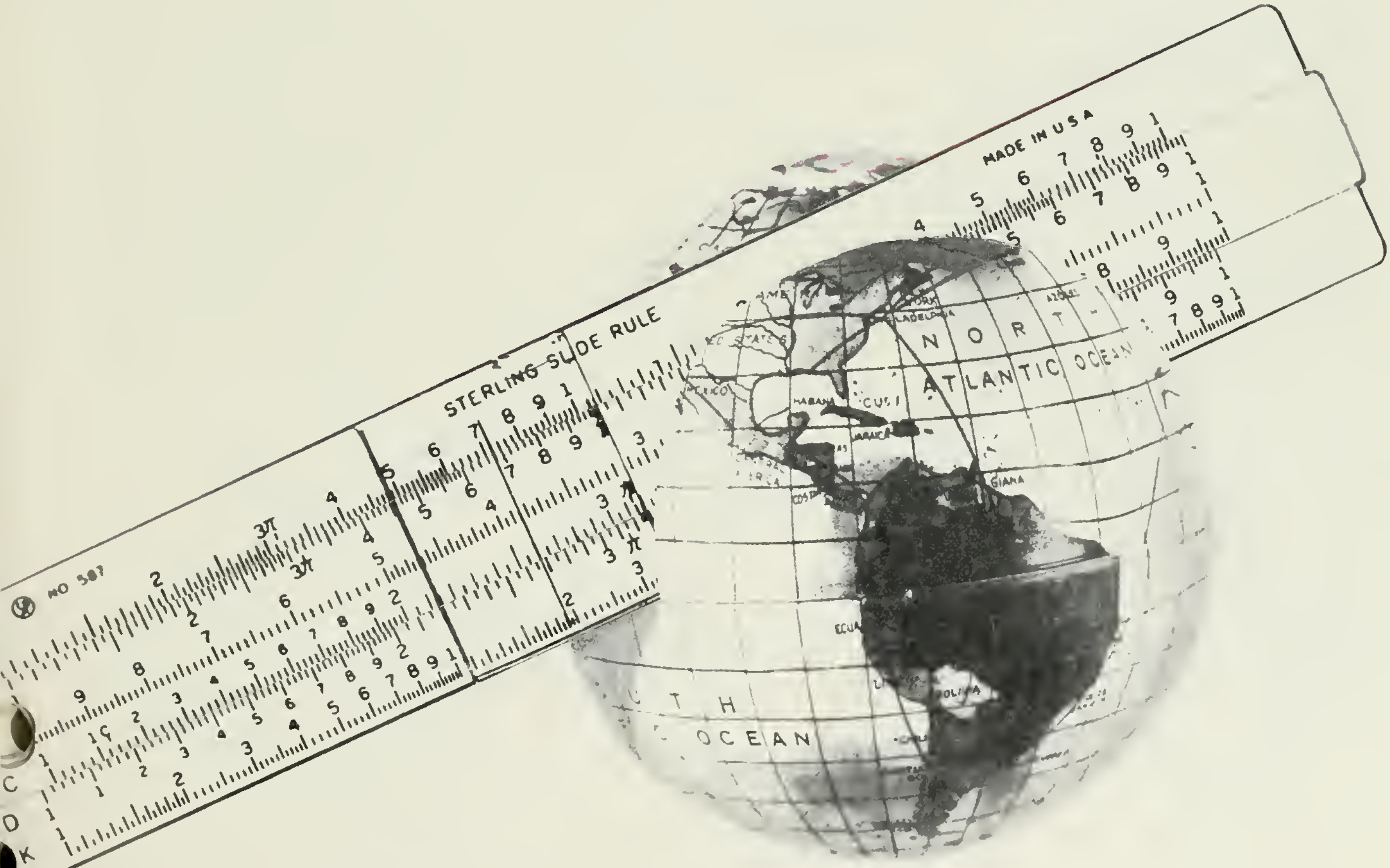
So if you're an engineer who's bothered by social problems, you're in a unique position to help.

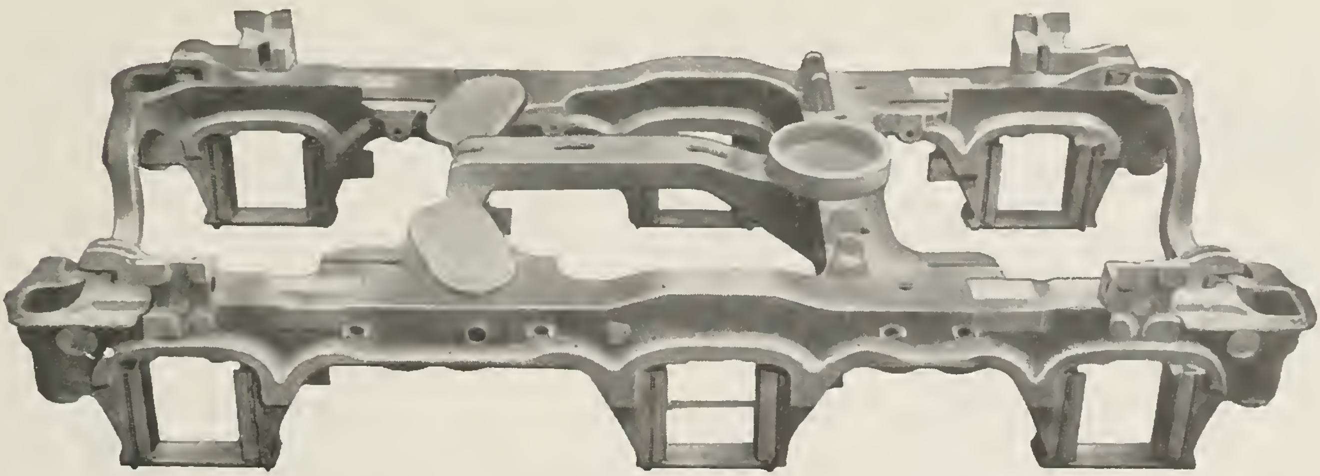
General Electric could use your help. We see more problems around us than we know how to solve. So what we need is more engineers.

GENERAL ELECTRIC

An equal opportunity employer

TECHNOGRAPH





TECHNOGRAPH

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Galen Rath

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COVER

This month's cover shows how some people view engineering. This month's articles tell both sides of the story. John Mendenhall created this month's cover.

CIRCLE GAME

Where have all the students gone?

Stand in the middle of the quad at noon sometime, stupid.

No. I know where their bodies are; I want to know where their minds are. The minds, souls, and spirits of last spring. The minds that could no longer tolerate the policies of their government. The souls that refused to condone the senseless killing of any inhabitant of the earth. The spirits that propelled them into the streets to cry: Stop. Let's stop the machine and see just where we are going.

Are they dead--or just sleeping? Have promises of repression from government and university officials cowed students? Perhaps the war becomes a little less repulsive when a person holds a high lottery number, and that person's life is no longer on the line. Perhaps the presence of recruiters on campus becomes slightly more acceptable when GE offers a young engineer a $10,000-a-year job. Or perhaps Nixon and Agnew are right: the deep student feelings of last spring can be soothed by a few well placed draft exemptions and condolences in the official government reports.

Meanwhile. . .

The Boneyard chokes on its own putrid wastes. The fight for Allerton putters along with empty bandwagons as student interest in the ecology movement dwindles (Even Ralph Nader's condemnation of student hypocrisy evoked only disinterested sighs). The move for student representation on vital policy-making bodies lies dormant. Student interest in ending the exploitive policies of local merchants and landlords appears minimal.

In other words, everything seems to be right back where it started.

Will anyone ever remember? Can any one ever forget?

They're "shooting the curl" in Phoenix.

TWO VIEWS ON RECRUITING

by Marsha Kuhn

Last March the right of the University to have on-campus recruiting was seriously brought into question for the first time here by the General Electric disturbances. Recruiting by companies engaged in "immoral activities"--anything from pollution of the environment and production of war materials, to exploitation of consumers and employees--was again an issue during the May strike. General Motors interviewers were under heavy guard during their campus visit in October while union auto workers and students picketed the area.

The engineering campus quickly became the center of this protest since many people looked upon the College of Engineering as a training ground for those with technical expertise who would eventually work for many of the companies engaged in "immoral activities." The controversial Illiac IV computer, funded in large part by the Department of Defense and supposedly scheduled for some use in war calculations, was a special point of dispute.

Two of the University faculty personally involved on opposite sides of the battle over the on-campus recruiting problem are Howard Wakeland, Associate Dean of the College of Engineering and the man in charge of recruiting for the engineering campus, and Phil Meranto, Assistant Professor of Political Science and a key figure in the May and October protests. They were interviewed after the October protest for their opinions on issues of on-campus recruiting.

Dean Wakeland feels he and the University are in agreement when he says students have a right to see recruiters--on campus.

"In college, there are certain rights an individual has," said Wakeland. "If he wants to interview, he has a right to do so."

To facilitate this right, the college lends a hand with room space, matching up students with prospective employers during mutual free times, announcing times when recruiters will be in the area.

Yet Wakeland draws a strong line between these aids to the student and the idea that these

October strike

Dean Wakeland

services encourage a student to work for the company involved.

"To correct any wrong that may exist in a company, you place the company on the open market for recruiting," Wakeland explained. "I'm not so sure we have the capability to judge who the good or bad companies are, though."

Morality, at least for Wakeland, is not a question.

"It would be impossible to judge which companies should or should not come," said Wakeland. "We would be presuming that the individual company makes a product that is all good or all bad. But producing a product does not make it good or bad."

What makes it good or bad, according to Wakeland, is how the product is used.

"The engineer is not different than the rest of society," said Wakeland. "The teacher is involved in the same types of judgments. Does the teacher not teach about revolution because it's bad? Of course not. He tries to give the total picture and let the individual student decide." Wakeland added, "If we were to get into the judgment of industry, where do we stop with judging the morality of schools? Could we ever pass judgment on a student, say he's morally good or he's morally bad? Our product--the students--can be used for good or evil."

According to Wakeland on-campus recruiting is a service. He feels students gain additional education through talking with a variety of businessmen about their professions, as well as corporations gaining better understanding of students.

Good will is not what makes the recruiting program a success, however.

"If we only saw ten to fifteen percent of the students use placement services, we would seriously question the effectiveness of the program said Wakeland. "But 95% of our students have heavily participated, not to mention students from other schools. Recruiting is not limited to one school. If in the judgment of our students or the university we were not doing our job, we'd be sent out of business.

Apparently they are doing their job. Last spring a questionnaire filled out by engineering students during the May strike showed overwhelming support of the program--2,600 in favor of on-campus recruiting. The suggestion that faculty members might have pressured students to fill out their sheets in a favorable manner was rejected by Wakeland.

"It was completely arranged by the students," said Wakeland. " did not know it was in process until it was well underway. To say there was prejudice is ridiculous. If the staff saw any sign of pressure, they would rebel."

In trying to deal with morality, Wakeland admits his department has not stressed engineering professionalism or what is ethical to do as an engineer in the business world.

"We're touching the same level

of morality as any other department," he said. "We don't play it real heavily." A well-rounded education is not the answer to engineers with little sense of the world around them either, Wakeland added.

"Students are not kept to a maximum about the number of courses they may take outside their field of study," he said, although a minimum of eight hours of social science and humanities is required. "But the social science courses are not a challenge to most students. They find them boring and usually don't take any more than they have to."

Yet the future of on-campus recruiting is not secure in spite of its support. Resistance in the forms of threats, pickets, and riots have had their results, which Wakeland estimates may decrease the number of recruiters in the future.

"Unfortunately it might tend to keep companies away that just don't want to go through the hassle of recruiting pressures," he said. "Now that jobs are tight, if companies see resentment, they may say it's not worth it and not come."

He hopes for legal solutions to today's production problems.

"If you don't like what's going on in the company," he suggested, "work inside the organization. If you can't and are still convinced the company is wrong, call legal action against them. Start procedures. If it means leaving the company, all right. There is a legal way to bring the attention of the public to these matters."

Phil Meranto does not quite have the confidence of Dean Wakeland on the legal process of change, to say the least. As one of the important figures in both the May and October protests, Meranto has become, in effect, the spokesman for those who think companies producing so-called "immoral" products should not be able to encourage students to work for them. . .for the good of everyone.

"University neutrality is a hoax," said Meranto. "Just by recruiting they're saying the

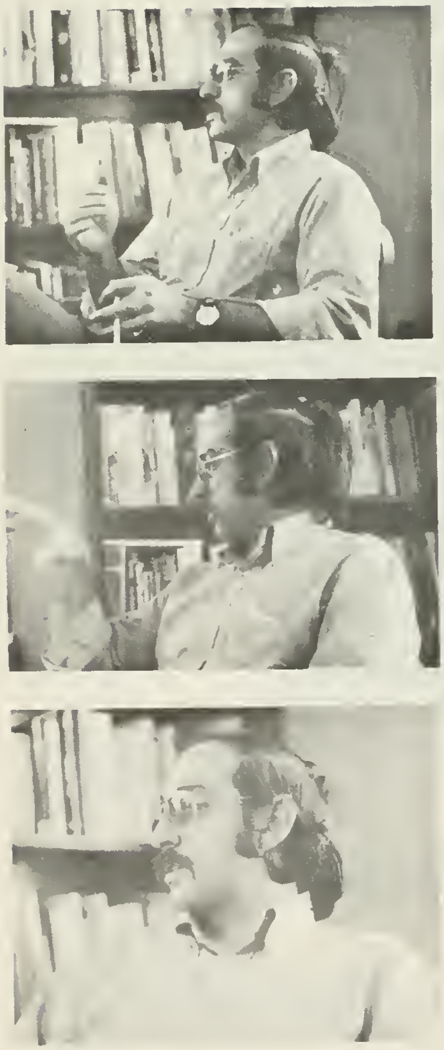
G. M. Protest

University does support this company because they are lending their services to see that it has a place to recruit."

To Meranto, this gives the corporation a blinding advantage.

"It's easy to recruit without people considering work they'll be doing or what it's effects will be on others," said Meranto. "They've got a nice office to talk in, a nice image."

According to some, behind that nice image, however, sit the pollution makers, the buck



Phil Meranto

seekers, the war machines.

"Because of that," he said, "We must have the corporations off campus. We can't let them use school facilities to further enhance their images for them. The important thing is that they don't gain any talent."

Meranto sees little hope for this move, however.

"The University is not capable of being reformed," said Meranto. "It's in part a political education instrument to indoctrinate the students."

"Whereas a segment of the University is counter to its ideas," Meranto explained, "general university policy cannot afford to take those stands because the base is government and the businesses."

He was perhaps speaking in part of the 700 votes that were cast against on-campus recruiting earlier this year. Yet the minority could be a majority.

"The most powerful minority today are those that own the corporations," said Meranto. "It's the people who are the minority at this point. Students represent a majority as far as those being exploited by the corporations."

A change in the power structure is what Meranto hopes for.

"We need to engage in a better political education campaign," he said. "Just a few years ago no one was questioning the government. It's not surprising that people are not yet radical."

He thinks the radical movement will win, however.

"They're in the process of winning the people over because they have a correct analysis of the world," he explained. "The controlling forces can no longer explain the contradictions of richness in the midst of poverty, hunger in the midst of bounty, peace and war. The radicals are winning because they happen to be true."

The radicals supposedly won their first victory last March when, for perhaps the first time, leafletting to attend a rally protesting recruiting got results. . .more results than the campus had ever seen.

"The General Electric trouble

is similar to what happened in black cities across the nation," said Meranto. "It came at a time when grievances had been swelling up. Of course, cancelling Kunstler's planned speech helped quite a bit."

To Meranto the idealistic answer would be to form a new, more socialistic society. But there are many alternatives, he added.

"We have to make more reflective moral systems," said Meranto. "The alternative would be to create different types of work situations, new social order. An example would be Earthworks on campus--a business not based on individual competition and profit, but based on the idea of aiding each other."

Recruiting in general is Meranto's complaint.

"There was no conscious effort to select out the engineering recruiters," said Meranto. "It just happened with General Motors that the idea of creating a new social order then included the students being in alliance with working class people."

The talk of closing universities to get rid of campus radicals seems to Meranto the worst thing the establishment could do.

"If the universities shut down, I'm sure there would be a massive counter-culture formed," said Meranto. "The kids would not go back to their parents. There would be no jobs for them. The seven million people employed in higher education are technically needed by society. Put them out of work and they'll be more radical than they are now."

In any event, says Meranto, the corporation does not work for society.

"How could you possibly make a peaceful gun?" he asked.

Marsha Kuhn

If you are a senior...

1971


PROTECT THE EARTH

L.A.S.

by Mark Parkin

No writer has emerged without first having been steeped in the elements of his literary and cultural past. While there are many influences on a writer, few have as much importance as the recent past and the present environment. Whitman, writing as industrialization progressed, wrote passionately of the modern, and foresaw the expansion of modernism in the future. His view of progress was humanistic, strongly reflecting the spirit and ideas of humanitarian reform which had emerged in the pre-Civil War era. Twentieth-century writers looked back on the beginnings of modernism and created a literature of great power. But they were also affected by the recent World Wars. Hemingway, for example, realizes the impossibility of man to achieve his goals in the face of a natural destructive order.[1]

I mention this because perhaps the most striking aspect of Thomas Parkinson's writing is the way it reflects the literary trends of the past while also reflecting the cultural changes of the sixties. The influence of twentieth-century writers is beyond question. Parkinson alludes to Robert Duncan in the beginning of "Yes, Beautiful Rare Wilderness," and moves quickly to a long discussion based on a William Butler Yeats' line, "Those terrible implacable straight lines/Drawn through

BOOK REVIEW

Protect the Earth is a short paperback essay by a Berkeley English professor on the state of the nation. We felt that the highly subjective nature of both the material and the media would lend itself well to parallel analyses by an engineer and a liberal arts student.

Mark Parkin is a junior in English. Lynn Barry is presently the Director of the Engineering Publications Office.

ENGINEERING

by Lynn Barry

Thomas Parkinson is an enraged poet. The object of his anger is man's "unearthliness," man's inhumanity to nature and to himself. As a poet, Parkinson addresses himself to his subject in a fashion which those with "rectilinear" minds will find difficult to understand and impossible to agree with. The combination of his rage and his poetry make **Protect the Earth** an illogical, yet emotionally powerful, book.

The thesis of **Protect the Earth** is simple. "As long as human beings go on building up levels of tolerance against abominations, the abominations will grow." In two short poetic pieces and two essays, this book explores the faults of the contemporary American society as seen through the eyes, and soul, of a senior professor of English at the University of California, Berkeley. His occupation and credentials conjure up a stereotype of a liberal-intellectual which Parkinson does little to dispel. His style, opinions, and choice of subject matter perpetuate the myth which seems to surround nearly all persons who have been associated with Berkeley in recent years.

Parkinson never lets the reader forget that he is a poet; his prose are so free that reading them is only slightly less difficult than reading blank verse. His arguments and conclusions are likewise based more on emotion and imagery than on reason and

LEAD puts quiet in flying conference rooms

Even with two powerful fan jet engines only a few feet away, these people can converse in normal tones. How? The interior designers of this Fan Jet Falcon business aircraft specified a lead impregnated vinyl sheet to be sandwiched between the plane's outer skin and interior trim. Lead's density effectively bars both noise and vibration—makes flying more productive, more enjoyable. ☐ Lead alone, or combined with other materials, is one of our best weapons against noise pollution; it's being used in planes, boats, offices, schools and heavy machinery. Designers and architects know that "lead can make life more liveable—by hushing things up."

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L.A.S.

the wandering vegetative dream." Parkinson directs this essay to the idea of the world as a dream. Dreams are without control. People, places, objects are all without origin in a dream. Even time becomes distorted as the dream passes from one place to the next. If the world is a dream, then it is man who is responsible for imposing those "implacable straight lines." He is incensed with views such as Eric Hoffer's, that "the globe should be our and not nature's home."

But Parkinson's is more than a literary appreciation of nature. The book stems from a religious "conviction that so long as human beings go on building up levels of tolerance against the abominable, the abominations will grow." He is concerned with the survival of natural order. If man continues to try to control the natural order, and succeeds, the end of natural order will necessarily mean the end of man. The dream of the world will be gone, but with it will go the dreamers. What is worse is that this drive to control nature is becoming a force that is accelerating, a force that is a power unto itself, a force that is perpetuated by the governing forces of the United States.

This transition from a general discussion of ecology to a strong criticism of the leaders of the government is presented in "In A Time Of War." This section, by analyzing various concepts as Astrophysics, Philosophy, Religion, Capitalism and Poetics, shows that all are a part of each other, and that all are a part of one large system. To favor one area over another is **unnatural.** For the government to allow and aid the advancement of some areas while restricting others is unnatural and therefore wrong.

He moves then to his essay "Berkeley." The emotion in his writing builds up through the first two sections and he now begins to release it. The question, "How can an American city be attacked from the air by an arm of its own government?," asked in relation to the attack on People's Park in Berkeley, reflects his amazement that those who control the armed forces, and those who run the government could allow such a thing to happen. He is strongly affected by the cultural movement of the youth of the sixties, those who "want peace;. . .want freedom, brotherhood and equality for all citizens regardless of skin color or religion;. . .want freedom of expression in music, writing, and speech, since they take the first amendment to the Constitution literally;. . .want an environment that has dignity, quality, beauty, and (who) want a world where man can live in an easy balance and inner harmony with the plants and animals of the world."

Parkinson concludes with "A Litany For The American People," a powerful literary device that is extremely successful. The emotions that were released in "Berkeley" reach a peak in the "Litany" Parkinson is demanding that the People of the United States must act as one in rejecting the governing forces as long as these forces continue to destroy the natural order. The form of the "Litany" Parkinson is demanding that the People of the United States must act as one in rejecting the governing forces as long as these forces continue to destroy the natural order. The form of the "Litany" shows that the people must respond as an opposing force, one which will deccelerate the governing forces. They must refuse to support those who will eventually destroy all. If the Governing Forces of the United States say:

"We will murder, slash, burn, bomb until we have annihilated any love and trust between men."

We must respond: "COUNT ME OUT, COUNT ME OUT, COUNT ME OUT."

---

[1]**American Literature, Tradition and Innovation,** ed. by Harrison T. Meserole, Walter Sutton, Brom Weber; Heath and Co., 1969, pages 1855-1859, 3082.

ENGINEERING

logic. In a rambling defense of the preservation and restoration of nature, "Yes, Beautiful Rare Wilderness!", Parkinson attacks technology as "those implacable straight lines, drawn through the wandering vegatative dreams." He sees science fiction as an ominous prediction of a future that knows no concern for any biological entity other than man. Despite his obvious technical lackings, Parkinson has tried to provide a defense of nature; instead of **how** to save nature, he provides the **why** of saving nature.

In a second essay, "Berkeley," the subject shifts from ecology to a much more political issue. In a straightforward, but emotional manner, Parkinson relates the story of the events leading up to the now-famous Berkeley confrontation over the "People's Park." As a near observer and sometimes participant in the turmoil surrounding the park, Parkinson makes no attempt to objectively report the circumstances which eventually led to an airborne tear gas attack of the Berkeley campus. Using this event as his foundation, he proceeds with familiar arguments that this confrontation is symptomatic of a disease infecting all of our society. There is much here to be agreed with or much to be argued, depending on your own views. But, there is little to be received unemotionally.

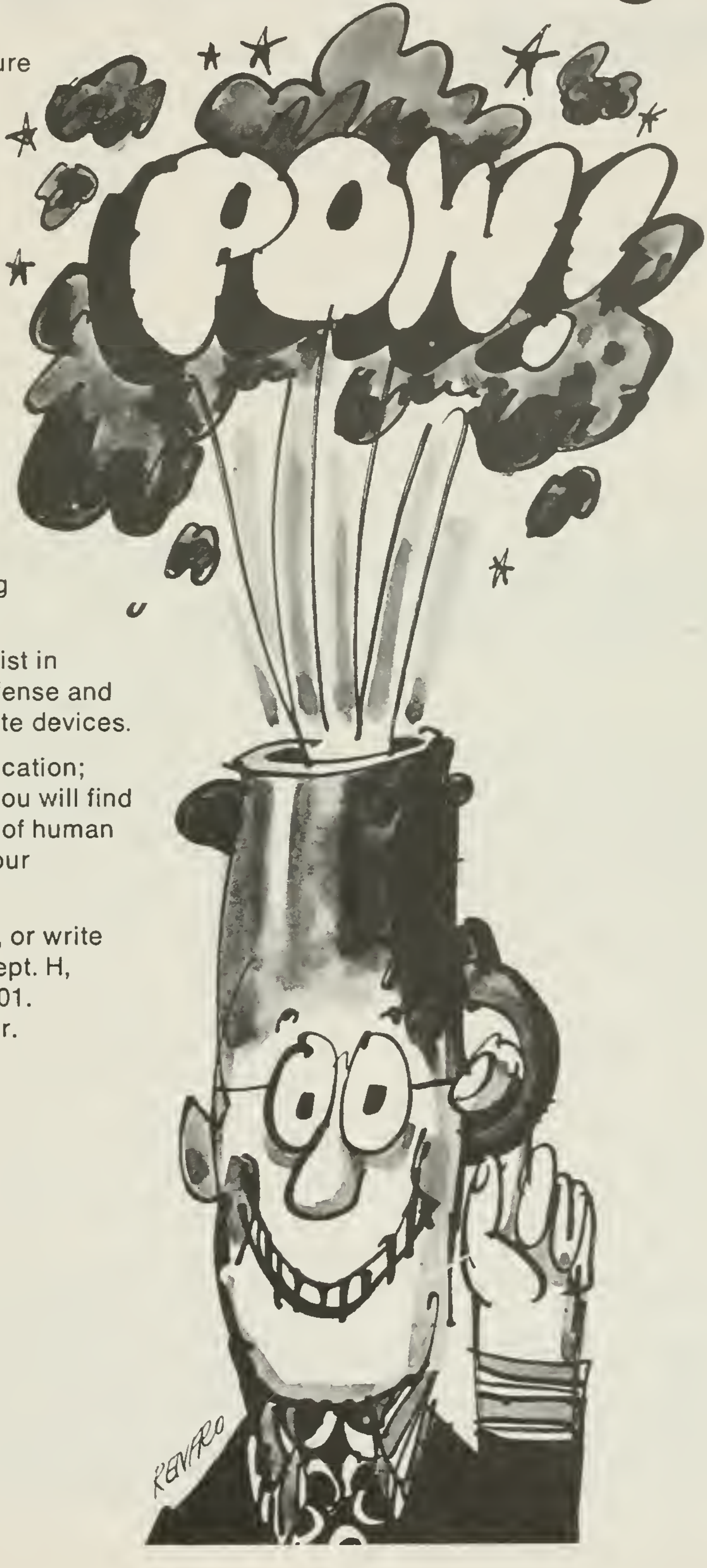
The two remaining pieces are poetic; one so enigmatic as to defy understanding; and the other a capstone to the book. "In a Time of War" is a poem about peace. Beyond this bit of intelligence, derived from the author's preface, there is little that can be added. It defies description or analysis. As prose, it is poetic; as poetry, it is far too wordy. As a message, it is vague and ambiguous. It stands in direct conflict to the remaining article, "A Litany for the American People."

"Litany" is a powerful and emotional chanting of all the faults which Parkinson feels characterize America. As a dialog between the governing forces and the people of the United States, the poem wails its doleful way through each vice Parkinson attributes to America: capitalism, racism, wastefulness, law and order, defense, and war. The sense of rage festering in Parkinson comes to the surface more plainly here than anywhere else in the book. The only optimism that Parkinson permits himself is American people's rejection of the "governing forces" of the United States.

Protect the Earth is an unusual combination of prose, poetry, and polemic. This is not a volume that most engineers will enjoy. Parkinson has written specifically to offend the rectilinear mind which dotes on straight lines in preference to the wandering vegatative dream that he feels should be America. He feels that by listing all the "abominations" that he may achieve a catharsis for both himself and society.

What Parkinson does not address himself to is suitable alternatives for the problems he has cited. Many will agree that there is much wrong in American society today. Parkinson, by only calling attention to the problems of America, adds his name to a growing list of authors who have done the same, in many cases, more effectively. He has done a disservice by limiting himself to mentioning them without offering a rational plan of alleviating or removing them.

Even though this is the chief shortcoming, **Protect the Earth** should not be rejected *a priori* for this reason alone. Some could profit from the reading of what seems so obvious to many and so obscure and vague to others. Engineers should read **Protect the Earth** -- twice if they disagree with it.



POW!

WRITE-IN

SOLUTION: SPIRITUAL REVOLUTION

Although **Technograph** *usually cannot publish letters of as great a length as the following, we made an exception in hopes of encouraging others to write to us.*

In the spring semester of 1970 the University of Illinois and universities across the country were faced with student strikes and unrest. What were the issues?. . .the war in Vietnam, Cambodia involvement, Kent State, racism, murder, violence. Peace. Now was the chant of many students. But how? What is really needed for peace?

From an engineering standpoint, there doesn't seem to be a textbook with the proper formula or set of equations which yield a solution. With all the technological accomplishments of man, we still seem to be reaching out for a solution which goes beyond the power and capacities of the I.B.M. 360 computer. Although 90% of all the scientists who ever lived are alive today, knowledge alone does not seem to be enough in bringing about peace.

The engineer is challenged with a new problem. This problem, unique from any other that an engineer deals with, concerns the nature of man. Engineers contribute greatly to mankind with such developments as radio, modern transportation, giant skyscrapers, and life saving kidney machines. We can engineer medical equipment which will save a person's life from physical disease, but how do we engineer "machines" that will save man from the greatest of all?

In seeking a solution to the problem facing man, let us first of all define the real problem. The real problem is man. Let's face it, it's man that creates the Vietnams, racial hatred, violence, etc. Wherever we find men in the world we also find the results of man's inability to exist in peace, not just political peace, but the penetrating peace that grabs you deep down inside. Before man can be at peace with the world around him, it seems obvious that he must at first be at peace with himself.

Knowledge and education, while helpful, do not seem to be providing the solutions for this kind of peace. Laws, regulations, and rules also have shown to be inadequate in producing peace in the world today. We have laws which form what we believe to be strong moral guidelines, but how do we go about giving men the power and self-discipline to abide by these moral contracts? It's great to talk about loving your neighbor, but how do you do it?

I am convinced, as an engineer, that the only solution to the disease known as human nature is the person Jesus Christ. Jesus? Yes, that's right. He doesn't have His initials engraved on your slide rule anywhere, yet I believe He provides the solution to the problem.

Jesus said, "For from within, out of the heart of men, proceed the evil thoughts and fornications, thefts, murders, adulteries, deeds of coveting and wickedness, as well as deceit, sensuality, envy, slander, pride and foolishness."[1] Jesus was "demonstrating" against man's messed up nature. But Christ didn't dwell on the problem, He talked solution. "I came that they might have life, and might have it abundantly,"[2] were the words of Christ. Jesus also said, "Peace I leave with you; my peace I give to you; not as the world gives, do I give to you. Let not your heart be troubled, nor let it be fearful."[3] Either Jesus is telling the truth or He is lying. To make the kind of statements that Jesus made one would either have to be a mad man or a lunatic or something worse, or one would have to be God Himself. There doesn't seem to be a middle of the road position which says that Jesus was just a good moral man who said some nice things. He's either God or some sort of crazy person; His statements were so profound.

You cannot build peace on the cracked foundation of human nature. You can build peace on the person of Jesus Christ. God loves you and He is ready to communicate with you today, if you'll allow Him to.

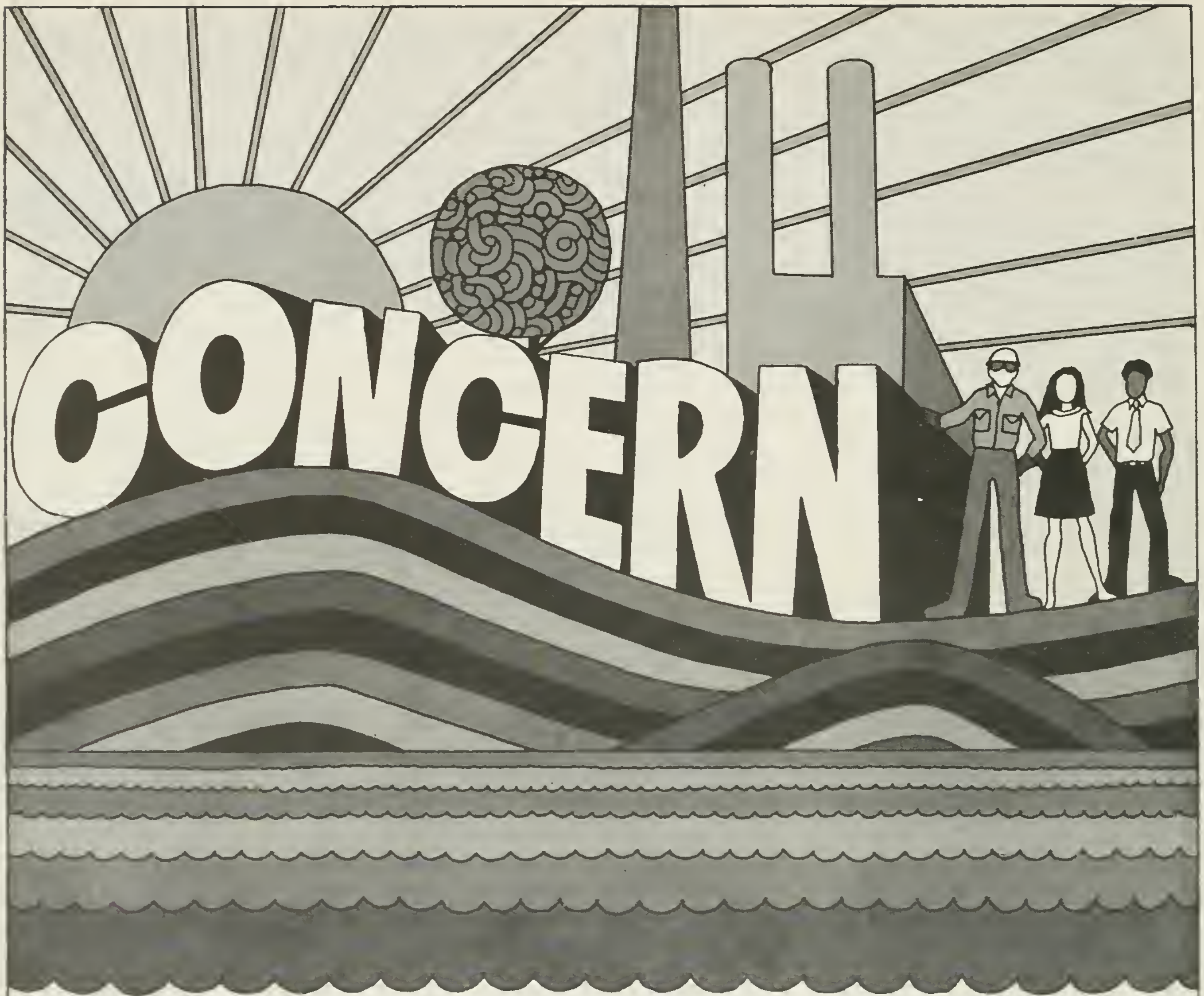
Through Christ you can experience a personal relationship with God. His peace is a real bridge over troubled waters. He has the power to change your life, give you a new start in life, and give real peace.

(Christ's personal invitation to everyone of us) "Behold, I stand at the door and knock; if anyone hears my voice and opens the door, I will come in to Him. . ."[4] This is what Christ is all about. He's not an impersonal religion but a person with whom you can have a living relationship by following Him. Why not open the door of your life to Jesus? If you ask Christ to come into your life, He will. Why?. . . .because Christ says He will and Jesus is not a liar. He says what He means. I challenge men everywhere to talk to God (pray) and ask Christ to come in. He yields the solution to the real problems facing man. Only through Him will we experience a Peace Now.

Mark Turek, E. E.

[1] Mark 7:21-22
[2] John 10:10b
[3] John 14:27
[4] Revelation 3:20

All Bible references taken from the New American Standard New Testament.



If you're concerned about society and the quality of life, consider a career with Bethlehem Steel.

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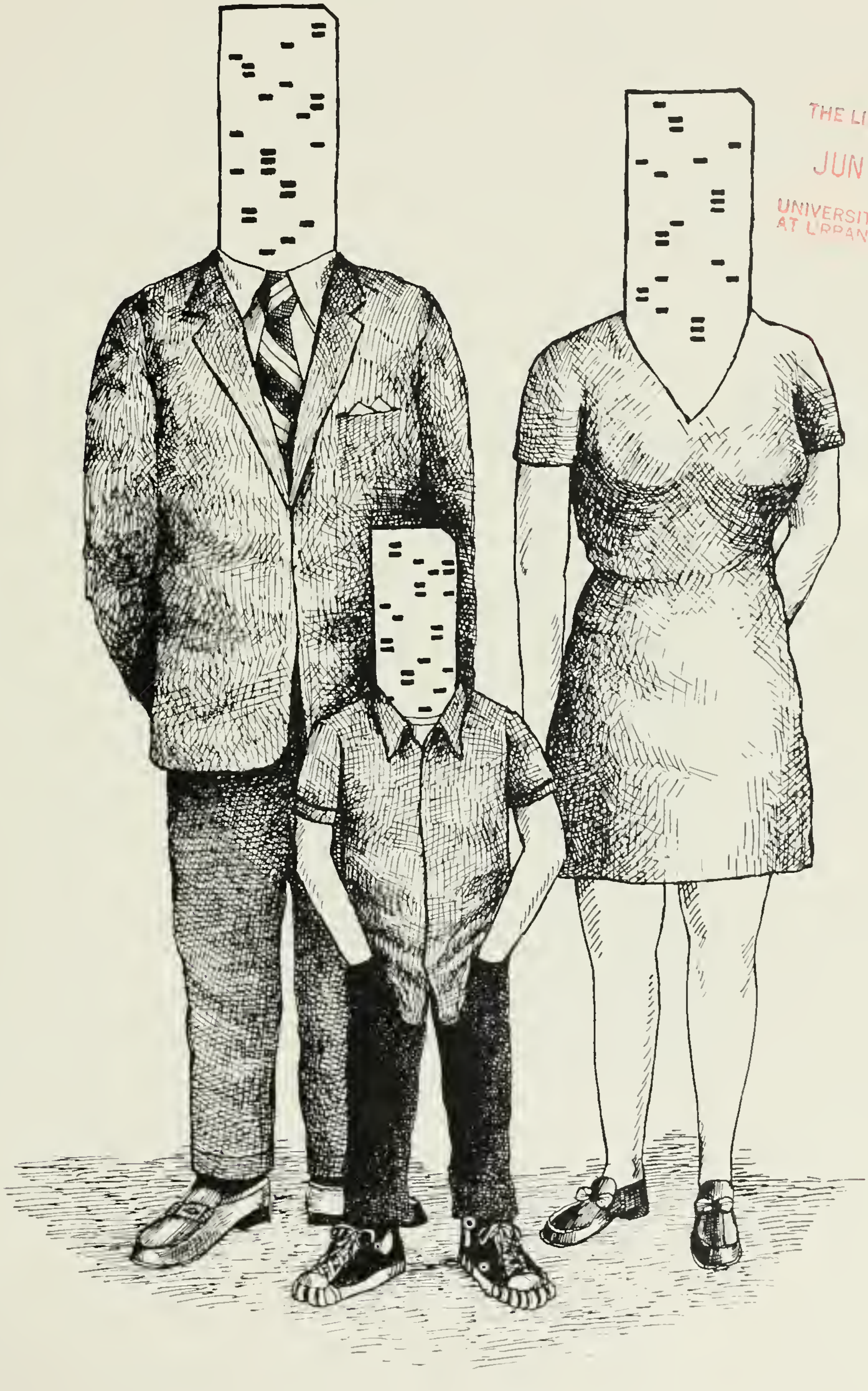
TECHNOGRAPH



// TECHNOGRAPH Vol. 86, 4

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Cover

First Man:

I think, I think I am, therefore I am, I think.

Establishment:

Of course you are my bright little star.
I've miles
And miles
Of Files
Pretty files of your forefather's fruit
and now to suit our
great computer,
You're magnetic ink.

From "In the Beginning", a song on the Moody Blues' album On the Threshold of a Dream.

Illiac IV: All in the Family

by Brent Jones

Illiac IV, the sophisticated descendant of the Illiac family of computers, will soon be assembled and tested by the Burroughs Corporation at their Great Valley Laboratories in Paoli, Pennsylvania. This machine represents not only a leap in computer technology and engineering, but also thousands of work hours by hundreds of individuals.

Of those people, Professor D. L. Slotnick leads in time spent on the machine's development. He currently is Director of the Center for Advanced Computation at the University of Illinois and also head of the Illiac IV project. Dr. Slotnick graduated from Columbia University in 1951 with a Bachelor's Degree in Mathematics. After he received his Master's Degree, also in math, he worked two years at Columbia's Institute for Advanced Study. Obtaining his Ph.D in Celestial Mechanics at New York University's Institute of Mathematical Science, Slotnick studied on the electronic computer project at Princeton University. He spent four years with IBM and then worked at Westinghouse for about four more years. While with Westinghose, Slotnick worked on a line of Parallel Prototype Computers called Solomon computers. In 1965 Dr. Slotnick joined the staff at the U. of I.

The original idea for a Parallel Type Computer came to Slotnick in 1953 or 54, while working under Dr. Hohn Phenon at Princeton. At that time, however, only electron tube machines were in existence. Phenon told Slotnick that because of the great number of tubes needed for such a computer, breakdown would occur too often to make the machine practical. But when transistors and drum track input/output appeared in the early '60's Slotnick found that a huge Parallel Computer just might have a chance. With the advent of integrated circuits the system could even be expanded.

The Illiac line of computers began in 1952 with Illiac I, an electron tube computer which could do approximately 11,000 arithmetic operations in one second. In 1963 Illiac II, a transistor and diode circuit computer, became operational; it was capable of computational speeds nearly fifty times as fast as Illiac I. Illiac III was built to rapidly scan visual data.

Rather than one huge computer, Illiac IV can best be described as a gang of 64 computers, or more precisely processors. These 64 processing units are under the control of one central unit which directs the processing units as a whole. In general, the control unit will send out a series of commands to each of the processing units and then each processing unit will take its own particular data and perform calculations upon it. That is, the instructions for the processing units are the same but the data sets are different.

This is the parallel feature of Illiac IV that sets it apart from the conventional "sequential" computers that are now in general use. Most computers have one processing unit; when many similar computations are required, the computer's control center puts the machine in a "loop." Illiac IV's simltaneous operation allows for a time reduction of at least 200 to 1 over other computers. This corresponds to a rate of between 100 and 200 million instructions per second.

A processing unit for the Illiac IV corresponds to a fairly larger computer itself. Each processing unit contains a processing element for arithmetic and logic along with an associated memory unit. The processing elements have about 12,000 switching circuits each containing around 100,000 components. Computation is done on 64 bit numbers.

Since it must deal with vast quantities of statistics, Illiac IV has a variety of memory features. The normal memory for the processing element is a 2048--64 bit-word thin film memory. There is a distributed memory system; each processing element has a memory. The memory is designed for a 250-nanosecond read-write cycle and can accept data from processor elements or from external memory devices. The memory can send data to the processor, the control unit or to external memory devices. Word transfer between individual processor element memories is also a system feature. In addition to the primary system mentioned above which has a high-speed storage of some 8.4 million bits, the Burroughs Parallel Disk File acts as a principal storage element. Each disk file resembles a phonographic disk and has 192 active information tracks which provide a total capacity of 78, 796,800 bits per disk. The approximate transfer rate from the disk file to and from the control unit is 500 x 10 bits per second.

The new "archival" memory whose writing mechanism is a laser beam will also hold data for Illiac IV. Developed by the Precision Instrument Company, this system can store one trillion bits of information. An argon laser beam records binary data onto a metal film coating of a polyester base, which is carried by a rotating drum. The read-and-record rate is four million bits a second.

To complete the system, a B6500 computer will serve as the principal managing element. All executive control, facility allocation, peripheral-equipment control, I/O processing and initialization fault recovery, and program assembly will be done by this subsystem. The primary functions of the I/O control computer are to execute the supervisory program for the Illiac IV complex and prepare programs for Illiac IV. The supervisory program controls the operation of Illiac IV, scheduled jobs for the array, maintains the disks, transmits control words and responds to interrupt conditions. Standard Burroughs units for I/O are used: magnetic tape, line printer, card reader, card punch, and console printer/keyboard.

The Illiac IV will be assembled in a modular design. Eight cabinets, each containing eight processors and eight memories, are bolted in a row with a ninth cabinet housing the control unit. The basic frame assembly of the processing unit is 46" high, 38" deep, and 4-7/8" wide and is made of 1/8" aluminum. The Processing element consists of four multilayer printed-circuit cards mounted on an open frame. Connectors mounted on the frame provide a pluggable

Professor Slotnick...well-identified, valid needs.

interface for the processing to memory interconnections.

The microelectronic circuit techniques used to implement the Illiac IV logic represent the first practical use of Multi Medium Scale Integrated (MMSI) packaging. This innovation in circuit design and fabrication has been made possible by Texas Instruments Company, a major subcontractor to Burroughs Corporation. More than 80 percent of the system logic for Illiac IV is implemented through the use of MMSI chip arrays. These arrays are used extensively in the processors (approximately 175 per processor). Their utilization reduces power and space requirements, and increases system speed.

A multi-chip array packaging technique is employed. Three to four monolithic chips, approximately 120 mil square, containing 15 to 20 gates, are alloyed onto a 1" x 1" ceramic substrate. Connections between chips and to the multilayer printed circuit board are made by a system of 64 lead wires. As many as 80 gates may be contained in a single 64-pin package. This package, occupying approximately 2 square inches of board area, is equivalent to 20 14-pin dual-in-line packages on a 4" x 5" card. In each processor element, 180 of the 64-pin packages will be mounted on four 10" x 20" multilayer boards. Each processor element occupies 1270 cubic inches. The same system, packaged in a conventional manner would occupy approximately 5200 cubic inches. The use of complex arrays has therefore permitted a 4:1 improvement in volume.

Reliability of the Illiac IV system is achieved through integrated electronics, component selection, minimization of connectors and controlled environment. A high reliability metal film was chosen for the approximately one million individual pull-down resistors. The air cooling system uses a loop of air controlled to 25°C and 50 percent relative humidity.

Maintainability is attained primarily through rapid isolation and removal of faulty processing units. The pull-replace time has been estimated at about 18 minutes. The faulty unit is diagnosed by a computer and repaired off-line. Then it is returned to the pool of spare processors. Because of the Illiac IV system's complexity--6 million components--the Illiac IV will be "down" about every 5 to 7 hours. This figure for the average run time between failures is however only an estimate. Results from new tests are constantly updating the number.

The total cost for the hardware alone is about 27 million dollars. This money is being supplied by the federal government through the Department of Defense. The University of Illinois has spent millions in research and development of the Illiac IV. Some of the primary users, besides the University of Illinois, include the Air Force, the Weather Bureau, and the Atomic Energy Commission. (Specific programming uses are detailed in another article in this issue of the **Technograph.)**

Campus opposition to the machine has caused Professor Slotnick to re-evaluate his position with respect to the project several times. Though his original ideas merely envisioned a complex, phenomenal computer, he now understands that a designer must consider uses and needs as well as technological problems. When asked if he planned to work on more advanced computer systems. Slotnick said that he would not develop any other computer unless there existed "well identified, valid needs."

Engineers and Seers

by David May

Astrology is important to many people these days. Millions read their horoscopes in the newspaper each morning. But this desire to know the future is nothing new; it is probably as old as man himself. Today's engineering student is not likely to think too highly of soothsayers and their methods. He is far too pragmatic and versed in science to believe those who prophesy. Yet the engineering student, perhaps more than any other student, is involved in predicting the future. He constantly asks himself what will happen to a physical situation if one or more of the factors are altered.

Today's engineers are being called upon to "prophesy" more than ever before on the effects of technology on society. In conjunction with sociologists, psychologists, and experts in many other specialized fields, the engineer today makes predictions on whose accuracy the success of economic, educational, political, and scientific endeavors depends. Nowhere are these attempts to predict the future more numerous than in the areas of computer application.

The future impact of the computer on our technology, social life, and politics appears in many respects likely to continue increasing at its present gradual pace. However, the consequences of the widespread application of the computer in certain areas may cause extensive change. Increased computer usage in the educational field in particular may exert major pressures toward change in all three of the above areas.

David May dons a prophet's cap to examine tomorrow's computer-dependent society.

Computer-assisted instruction in efforts such as the University of Illinois' PLATO program have shown great promise. The PLATO system, for example, may lead to a veritable revolution in education. The system offers individualized attention at the speed the student can handle. It eliminates the one-way flow of ideas that are found in many classroom situations. PLATO will free the teacher from some of the drudgery of his life and allow him to plan novel uses of this marvelous tool. The results, though not conclusive, indicate that use of PLATO decreases learning time while increasing retention and stimulating interest in the material. It is anticipated that the cost will be congenial to the budgets of educational institutions.

If, on the basis of this evidence, the hypothesis is accepted that all schools will be converting to a PLATO-nic form of computer-united instruction within a few years, spin-offs into other areas can easily be imagined.

Technology and science will

be advanced by men who are trained more thoroughly and quickly than today. Researchers will sooner reach the educational pinnacle which allows for further innovative research study so that their young creative years are not lost in continuing their education. Scientists, engineers, and other technical personnel will be accustomed to using computers and will doubtless use them in everyday work after graduation.

The effects on social life may increase in intensity. When terminals are placed in schools, the yearly grade system is certain to suffer. The exigencies of making the most economic use of computer time may deal a death blow to the five-day week, eight-hour day, and nine-month school schedule under which we operate today. If terminals are moved into the home the effect will likely be magnified many times. The need to attend school to learn will be lessened. Adult education will become eminently feasible. All people will be able to use the computer for whatever work, games, or study they wish.

Politicians will be faced with the new responsibility of making major policy decisions with possibly enormous long-range effects. America maintains a sort of hegemony over the computer world, and the gap is not narrowing. As the country with the means and ability to implement computer-assisted instruction, the U. S. (and a few other highly technical societies) will have to decide whether to hoard the benefits and knowledge accrued through the applications of this new technology or to share this valuable tool with developing nations. Applications directly to politics could be in the form of a mandatory "super-poll" in which people could use the computer terminals to learn about the doings of the government and the government could use the opportunity to better appraise the sentiments of the citizens.

The economics of computer usage may deal a death blow to today's school schedules.

These are but the possible results in our lifetime of the direct impact of present technology on but one institution of society. With more complex computers connected by ever more efficient and sophisticated communications networks, and with the possibility of standard English as a computer language the changes effected by computer technology alone are likely to be enormous. Nobody can say for certain what will happen, but rest assured that things are not going to be quite what they are today.

If you are a senior...

1971

Doors to the 21st Century

by Galen Rath

It will juggle a set of numbers and tell the city council where the best place is to put its new tennis court. Or perhaps tell an executive board that it shouldn't build a new factory at coordinates x and y because of possible damage to the environment. It should be able to produce a five-day weather forecast as accurate as any 48-hour forecase today, and it will be able to do it faster. It will apply elliptic partial differential equations in solving multi-group neutron diffusion calculations so that the ABC company can produce a more efficient and safer nuclear reactor for the people in the Great Lakes region. It will be analyzing information for a mental health hospital, and then a nanosecond later, it may be perusing Farmer John's 240 acres to find out why his well is going dry. And it will help to optimize Farmer John's agricultural output, too, or the output of an area the size of downstate Illinois or of an area as large as the nation.

It is "a tool which will be employed . . . to help realize better solutions to scientific and social problems," says the Center for Advanced Computation at the University of Illinois. And with a little ingenuity and sweat, the Illiac IV System should be a sledgehammer of a tool.

Illiac IV's great potential is in solving previously unsolvable problems involving the many variables and constraints and in dealing with projects requiring a large data base. Already the Center for Advanced Computation is working with the Departments of Computer Science, Psychology, Landscape Architecture, Agricultural Economics, General Engineering, Chemistry, Mathermatics, Political Science, and Zoology and with a number of national organizations in an interdisciplinary effort to utilize this potential.

One of the first projects to be initiated is the Natural Resource Information System (NARIS), sponsored by the Ford Foundation in cooperation with the Northeast Illinois Resource Service Center. NARIS is designed to help decision makers make rational decisions in using land and other natural resources.

Illiac IV will be able to store the vast amount of natural resource data required for the NARIS project. A geographical region under consideration will be divided into 40 acre tracts. Each tract, identified by an eight-digit code, will be described in the computer by eight attributes: soils, geology, hydrology, forestry and vegetation, climatology, water impoundment, topography, and land use. Land use data might tell how many acres are being used in tract 6947/5873 for bean crops or how much space is being used for one-story residences. Geology data would include characteristics such as the type of bedrock and the porosity of the ground.

By interpreting this data, Illiac IV will be able to tell if an area can support a manmade lake, a super highway, an electric power generation plant, or a recreational area, without a resulting decline in environmental quality.

An engineer considering possible routes for an underground pipeline could ask, "Will the path from X to Y to Z to P minimize both engineering costs and ecological damage?" If this proposed path is found to be unsatisfactory, NARIS will tell the user what private costs and social costs are involved, and after searching through the remaining data, will be able to suggest alternative routes that are satisfactory. "This kind of positive alternative response," says the Center, "will provide decision makers with a creative tool to achieve their own specific goals while having the means to consider the environment and the local resource base."

NARIS will be available for use by everybody. Very little knowledge of computers will be required for users to input data and questions and to obtain the information they need. Depending on the user's technical background and requirements, a choice of three output options are available: a simple inventory listing of sites and attributes, a computer report in readable prose, or a highly technical report that would be required by architects, ecologists, or earth scientists.

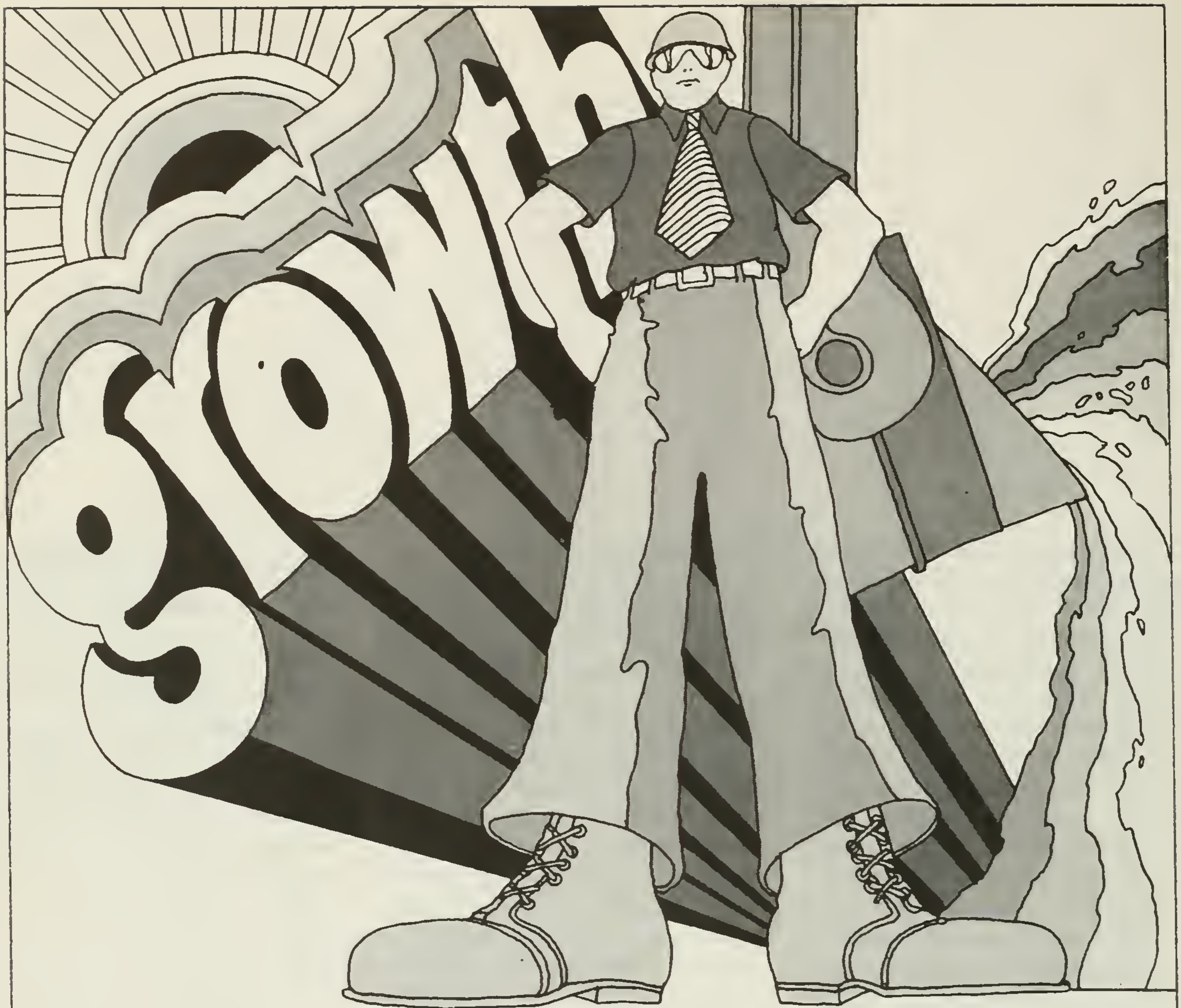
The NARIS concept will be tested in a pilot system for Marengo Township in McHenry County.

Says the Center, "If essential data can easily be obtained by decision makers, the length of the planning process and the corresponding work burden can be measurably lessened while producing a more informed decision. In addition, the ease of obtaining natural resource data should permit a wider consideration of many planning problems, thus leading to decisions involving less destructive use of the community's resources both for this, and for later generations."

Ian W. Marceau of the University of Illinois is directing another project to coordinate agricultural resources such as land, labor, machinery, fertilizers, pesticides, herbicides, storage facilities, and capital in order to optimize agricultural output on both large and small scales. As well as helping to optimize production, linear programming models of the region under consideration can take into account long term effects of nitrogen fertilizers, DDT, and excessive cultivation to help minimize the problems they cause.

The National Institute of Mental Health is funding a multi-state, psychiatric-information system. Illiac IV will be used to analyze information

Wider consideration of many planning problems, less destructive use of the communities resources.


growth

on patients admitted to public mental health hospitals. The system is centered in the Research Department of the Rockland State Hospital in Orangeburg, New York.

A research project in political science will use Illiac IV's abilities to determine "intervention" strategies for problems that develop within society; also to pinpoint the areas of social change that are noticeably different from the average," says the Center for Advanced Computation. It is hoped that researchers will be able to interpret social change in a short time. Usually, such analyses take several months or years. With the ability to test hypotheses relating to social interactions, the system will seek "to discover how changes in social and political systems will affect the course of events in our society."

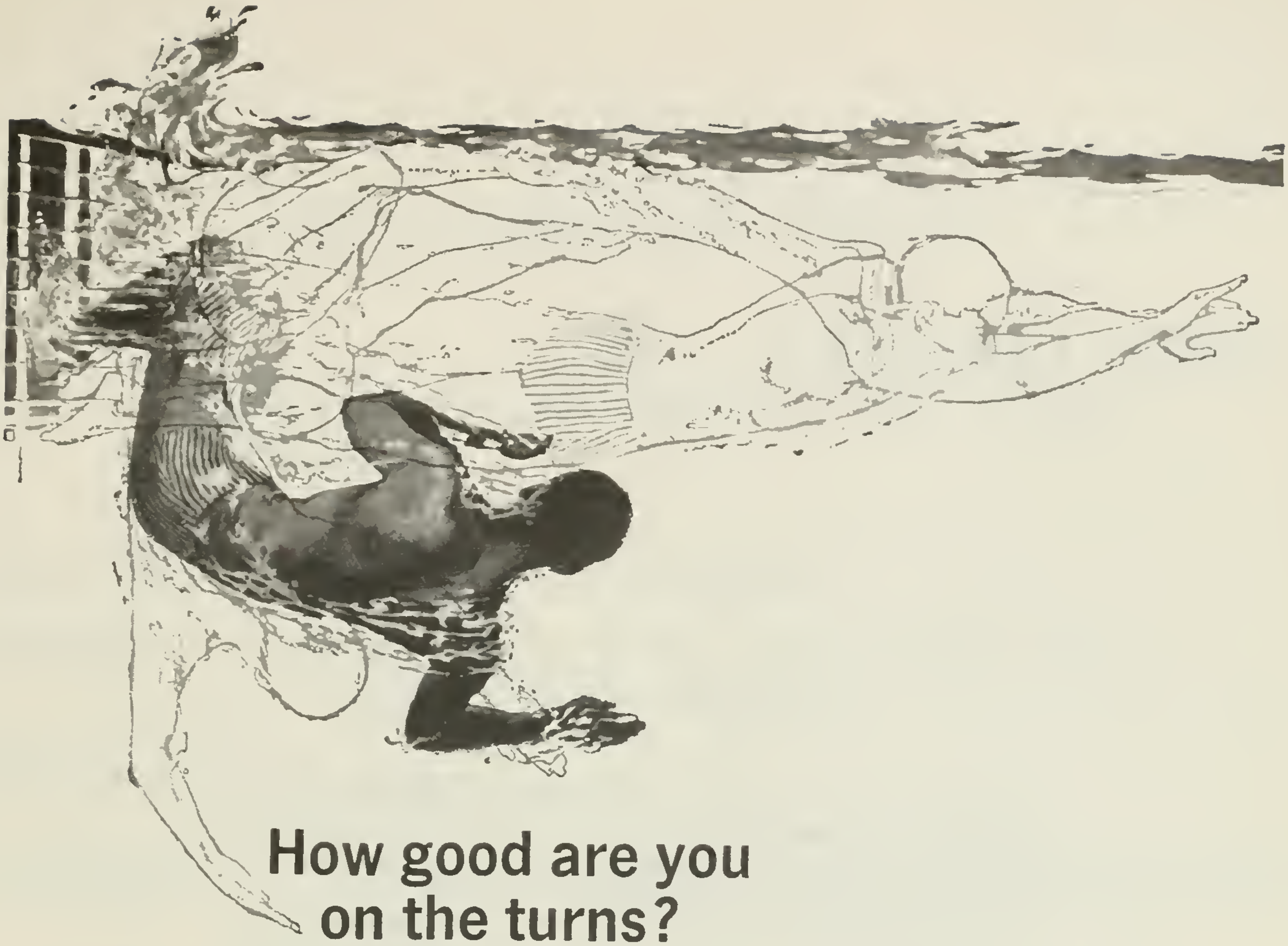
Simulation of atmospheric phenomena for applications such as weather prediction requires a number of complex calculations, so many in fact that little has been done in the area using numerical techniques. However, the sets of differential equations describing the movements of particles within a cloud, the movement of fronts, the development of clouds, and the effects of deserts on air flow could be solved more quickly and accurately using the Illiac IV system. The Laboratory for Atmospheric Research and the Center for Advanced Computation are studying the partial differential equations describing these physical systems. By using a modified version of the atmospheric data collection system used by the National Weather Service, five-day predictions as accurage as today's 48-hour predictions may be within reach using the Illiac IV system.

A number of seminars have been held to determine possibilities of applying the system to environmental problems. A proposed Environmental Studies Institute to be established at the University of Illinois' Urbana campus will undoubtedly work with the Center and the Illiac IV system in this area of application.

All in all,the Illiac IV system will enable us to optimize at a much larger level than before. Because a greater number of physical variables and constraints will be considered, our decisions will be based not only on economic factors and short-term objectives, but will reflect the national interests. Characterized by some as "so many bolts,' Illiac IV is a positive attempt to provide the people with a decision-making tool that will help to alleviate socio-economic and techno-economic problems.

In the February issue of *Scientific American,* Dr. D. L. Slotnick, designer of the Illiac IV system, says "It is in fact evident that we are currently faced with socially debilitating aftermaths of piecemeal planning--and non-planning. . . A rational 20th (or 21st) century society will not emerge solely on the basis of universal goodwill.

". . . I believe computers on the scale of Illiac IV will remove some of the very real barriers of capacity from certain calculations that have a direct bearing on our ablity to produce a rational and enduring basis for life."



How good are you on the turns?

A strong stroke isn't enough to win in freestyle swimming. Experts say: "Watch the turns."

"A champion won't touch with his hand," they tell us. "He begins his overhead tumble with a downward stab of his right arm, twists as his feet hit, then explodes forward with a powerful pushoff."

Their conclusion: "Experience and smart coaching develop a championship turn."

We believe it. That's why we've put together the most experienced and best-coached team of bearing and steel engineers in the world. And now we're putting $221,000,000 into expansion and modernization for the future.

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Dirty Laundry

This article is called dirty laundry because it deals with a topic which has not received widespread public attention. The subject is the future of the **Technograph** and the role of every engineering student on this campus in that future.

This engineering college has the distinction of being the only college in the university with a magazine designed specifically for and by the students. **Technograph's** 85 years of continuous service make it the second oldest magazine of its kind in the country. In the past **Technograph** has stood at the spearhead of major educational reforms in the college. Year after year **Technograph** has received awards from the Engineering College Magazine Association. Former staff members have gone on to pursue rewarding careers in both engineering and journalism.

Yet this tradition is being threatened by the apathy of engineering students. For the past two years the magazine has functioned--irregularly and ineffectively--with a skeleton staff. The number of people recruited in the past few years has been barely sufficient to publish the magazine, and the percentage of engineers on the staff has decreased. Because fewer engineers are involved in the magazine, the **Technograph's** ability to critically examine college policies has been blunted. The magazine's lack of engineering viewpoint or even feedback from readers has hampered the **Technograph's** ability to provide articles that might interest engineers.

Unless there is a large influx of new people the **Technograph** will probably fold after this year--not because of financial difficulties but because students simply did not care.

We will publish two more issues this year. If you decide not to work on the magazine, you might save those issues; they will make fine collector's items someday.

YES

i want to help save the technograph

SO

i would like to participate in one of the following areas

WRITING- articles for the magazine

DESIGN- covers, illustrations, photographs, and layout for the magazine

PRODUCTION- putting it all together

BUSINESS- handling circulation, advertising, and writing checks

INTERDISCIPLINARY STAFF-
i don't know what my interests are, but i want to help

Name____________________
address____________________
phone____________________
curricula____________________ year__________

Please drop me in
302 engineering hall

Avoiding Deception

In recent years a body of critical, interpretative literature has arisen around questions concerning the values and place of technology in society. Gene Marine, in **America the Raped**, sees the engineer as a plunderer of the natural world. Charles Reich, in **The Greening of America**, states that technology is the prime value of a corrupted capitalist system. Alvin Toffler forsees far-reaching effects of technology on culture and individuals in his book **Future Shock**. Other authors, such as Mumford and Ehrlich, have suggested alternative premises that challenge previously held conceptions of the engineer's place in society.

Certainly not all the arguments presented by these men are entirely valid. But the real issue at stake is not the veracity of the works, but rather the engineer's familiarity with these authors' writings. It seems doubtful that many present or future engineers have read such works. Yet technology must function for the people, and if the layman does not understand or misinterprets the place of technology because of such books, true progress may well be impeded.

The engineer must address himself to such critics. To lightly dismiss all anti-technology attacks, no matter unjust or unsubstantiated, is an act of unforgivable intellectual arrogance. Government and public reponse will largely determine the uses of future technology. If people read, and believe, works condemming engineers, the most useful application can serve no purpose.

Engineers need not respond to each objection raised, but they should at least read the works of those vocal critics whose works have received extensive public attention. This aspect of education is just as vital as keeping abreast of technical developments in one's field.

As Descartes said in his **Discourse on the Method**:

> . . .it is good to have examined all things, even those most full of superstition and falsehood, in order that we may know their just value, and avoid being deceived by them.

Even if you don't like the air you breathe, you can't stop breathing.

When was the last time you went out for a breath of fresh air and got it? How long has it been since the sky looked really blue?

Every day, our cities dump hundreds of thousands of tons of waste into the air. Carbon monoxide. Sulfur dioxide. Fluoride compounds. And plain old soot.

If something isn't done about air pollution in your lifetime, it may cut your lifetime short.

Air pollution can be controlled. The key is technology. Technology and the engineers who can make it work.

Engineers at General Electric are working on the problem from several directions.

Rapid transit is one. In many cities, the automobile causes more than half the air pollution. In some cities, as much as 90%. But engineers at GE are designing new equipment for rapid-transit systems, encouraging more people to leave their cars in the garage.

Another direction is nuclear power. General Electric's engineers designed the very first nuclear power plant ever licensed. A nuclear plant produces electricity without producing smoke. And as the need for new power plants continues to grow, that will make a big difference.

There are other ways General Electric is fighting air pollution. Maybe you'd like to help. We could use your help. But don't expect to come up with an overnight solution to the problem.

The solution will take a lot of people, a lot of talent and a lot of time. You'll breathe easier—once you get started.

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TECHNOGRAPH

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We've struck oil in Texas (a pipe in someone's backyard). And we've had to get a special repellent to keep gophers from eating the cable.

So if you still see a fair number of telephone poles around, bear with us. Our engineers are working as fast as they can to bury our lines.

And resurrect our scenery.

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TECHNOGRAPH

Vol. 86, 5

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Cover

Consciousness III framed against the symbol of power in the American Corporate State. See what Charles Reich and Sarah Steinberg have to say about the situation on page 14.

Cover photo by Alan Kuchek of The Daily Illini. Taken during April, 1971 march on Washington.

engineers

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A great many people can tell you what needs to be changed in the world . . . not many are prepared to work to make those changes. If changes are to be made, this generation of graduates will be the ones to make them . . . and make a difference in the future of our world.

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Directions

The failure of the recent Washington demonstrations seems to leave only two courses of action for today's activists. Violence and sabotage are the extrapolation and escalation of yesterday's patterns. But the overwhelming strength of government forces discourages such action. Even more important violence is a betrayal of those values which the movement wishes to instill in the country.

The other course involves cooperation in the community. Establishment of consumer protection groups, environmental clean-up groups, and cooperative stores and farms are small responses to the stilted values and priorities of America. Such actions are reasonably successful and, in some cases, have begun to mold a sense of community. These efforts should be applauded for they herald the beginning of a more sympathetic and peaceful society. These individuals' efforts will be the cornerstone of tomorrow's truly free society.

But this is not enough. Such change is painfully slow, and as long as power bureaucracies control those institutions that form today's values, such improvement will be, in the short run, inadequate. America's perverse system of priorities, the use of subtle and blatant coercion in politics, the absolutist Puritan value system that sees a grey world in shades of black and white, and an archaic educational system that con-forms rather than allow real learning—these are only a few of the structures which must be changed.

But how? Few of today's youth are willing to resort to violence. But still fewer are willing to be absorbed into and digested by the corporate state. The way of life outside the state is exceedingly hard; within the system, ideals are easily forgotten and forsaken in the name of comfortable conformity...

But the children of the bomb and television will eventually refuse to return. Their demands cannot be negotiated, their ideals cannot be subsumed. And once they have left, they will not return.

The state has seized their hopes and substituted fear, taken their honor and made them national scapegoats. They are left with only themselves. And they have found they have quite enough.

A Tribute to Champaign

by John Mendenhall

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Fill in the blanks with the appropriate word or words. Correct answers below.

The Twin Cities are two of the most __________ ____ communities in the Middle West. Often referred to as the _______________ communities in the country, Champaign-Urbana offers ____ ________ opportunities to all who ______ here. The ______________________ has been a prime factor in the growth of the area, however, recent industry and commercial developments have added another dimension to the rise in __________ of the area.

The Twin Cities are two of the most progressive communities in the Middle West. Often referred to as the fastest growing communities in the country, Champaign-Urbana offers tremendous opportunities to all who settle here. The University of Illinois has been a prime factor in the growth of the area, however, recent industry and commercial developments have added another dimension to the rise in popularity of the area.

Jig Saw Puzzle (suitable for framing)

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Quaker's continuing commitment to success demands an ability to grow and change . . . in this atmosphere there is no room for the engineer who avoids responsibility. If the future of our company is something you might like to be a part of, talk to our representative when he visits your campus or write to: Supervisor—College Relations, THE QUAKER OATS COMPANY, Merchandise Mart Plaza, Chicago, Illinois 60654. An Equal Opportunity Employer.

Our Representative will be on campus MARCH 1, 1971.

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Can you identify this famous Champaign skyscraper?

This weed grows throughout Champaign County. Do you know what it is? (Hint: people come here from miles around just to pick it!)

Know Your City Test

Time Limit: 30 Minutes.

1. How was Champaign founded?
   a) by mistake.
   b) nobody knows.
   c) nobody cares.
   d) all of the above.

2. The mean annual temperature in Champaign is
   a) 10 degrees.
   b) 12 degrees.
   c) 51.9 degrees.
   d) 14 degrees.
   (careful - this one is tricky!)

3. What is Champaign's greatest landmark?
   a) Boneyard Creek.
   b) The Illini Theater.
   c) Chuck Wagon Diner
   d) The Parking Lot Across From Sears.

4. Who is Lon Eubanks?
   a) Uncle John's Brother.
   b) Mayor of Champaign.
   c) The Busey Lady.
   d) None of the above.

5. What has been the longest running movie in Champaign?
   ____

6. What has been the biggest scandal in Champaign in recent history?
   a) What really happens at the Moose Club meetings.
   b) The truth about Papa Del.
   c) Mr. Robert's Secret Life.
   d) The real reason why Minnie Pearl had to leave town.

7. Pick the correct title of David Dodds Henry's memoirs.
   a) The Invisible Man.
   b) The Love Machine.
   c) Everything You Always Wanted to Know About Jack Peltason...But Were Afraid to Ask.
   d) Thunderball

8. What was Harv Shirley doing behind the English Building bushes last Thursday night? ______________________________
   ____

Answers: 1.d 2.c 3.d 4.c
5.The Stewardesses 6.a 7.

CONTEST!

In 25 words or less, tell why you'd like to spend the REST OF YOUR LIFE in Champaign.

Send entries to the Technograph no later than May 29, 1971.

1st Prize: A YEAR'S SUBSCRIPTION TO THE TECHNOGRAPH at reduced rates.

2nd Prize: THIS RECORD:

Red, White, and Green

by Sarah Steinberg

The quiet civil war: grey flannel suits vs. bluejeans.

Pretend it's the year 1984. Just imagine law-making by private power, uncontrolled technology, an all-powerful bureaucracy, pointless work in a plastic culture, loss of identity, and absence of community. What is the difference between Orwell's fiction and today's reality? In **1984** Big Brother held the power. Today, according to Charles Reich in his book **The Greening of America**, "there is nobody whatever on the other side." Nobody, that is, except the American Corporate State.

Why is another book on the Corporate State not wasting away on library shelves? This book is optimistic. It is a serious analysis of the crisis in America predicting the revolution which will save us--revolution that has already begun. "It will not require violence to succeed, and it cannot be successfully resisted by violence. This is the revolution of the new generation."

In his introductory discussion of the coming revolution, the author asserts that the above-mentioned problems are all elements of the American crisis. Our inability to act on them is ultimately caused by an unreality in our beliefs about the major structures, forces, and values of our world. Since we no longer understood the system, it, though obsolete, was permitted to assume power over us. This "understanding" is better termed "consciousness," an individual's total configuration including his whole perception of reality and his way of life. This consciousness was formed by economic and social conditions. However, it could lag behind the social system and be manipulated; then, it caused unreality.

Reich distinguishes three types of consciousness which exist in America today. The nineteenth century Consciousness I is that of the "Amercian Adams," striving to get ahead in a new nation. They believed in self-interest and the struggle against their fellow men seemed natural to them. They exist today, having lost contact with reality. The industrial revolution made them cogs in a machine which became increasingly organized, and the new corporate power, efficient and organized, subjugated them. Consciousness I people looked away, refusing or unable to see what was happening, seeing the bad effects of industrialism as moral problems. This caused a reform movement that created a public state which regulated all private activity "in the public interest." The rule of the expert began.

This New Deal era with its belief that one must live under domination produced Consciousness II. Although it grew out of the reform movement, the power it created over people's lives joined the overwhelming power of technology to produce the Corporate State. The people gave the machine power over their lives by their belief that one must sacrifice for a common good. Along with this, technology and its social application, organization, led to a new American hero--the professional. If one fell behind in the rat race, he became a nonperson. What is important here is a pessimistic view of man as an aggressive, powerseeking animal whose reason is the only thing which can improve him. Thus reality for Consciousness II "rests on the fiction of logic and machinery."

An important theme throughout the book is the nature of work. For Consciousness II, work means self-sacrificing oneself to functions needed by society and adopting its values as one's own. When the working day is over, the private self emerges from hiding. This is indeed schizophrenia, a loss of the reality of self.

There is no need to go into the deep analysis of the Corporate State that Mr. Reich presents. In brief, the Corporate State is a mindless machine which cannot be controlled, only manipulated by power interests. It is a vast corporation and each person is an involuntary employee. The demands of technology motivate its workings and its decisions are made by "experts."

One thing which surely establishes the credibility of this book as an open-minded, thoughtful work is Charles Reich's discussion of the "lawless use of law" in the Corporate State. Law, he says, was adapted to serve the "public interest," then it began to aid the work of the State. Law started by safeguarding the constitutional rights of corportions instead of individuals, declaring constitutional the policies the State deemed in "the interest of society," inadequately regulating allocations of resources, etc. There can only be real law in a political-conflict state, and the Corporate State wants order rather than conflict. Law has intervened between man and his humanity, as in the case of the draft. To Consciousness II virtue is to always obey the law. (Mr. Reich is a lawyer.)

Since I have thus far presented **Greening of America** in theoretical and general terms, I must emphasize that the author does not intend his classifications of consciousness to be rigid and that he uses many examples to support his views. However, he does not say much that needs to be proved. The reader will recognize the significance of the symptoms of our nation's ills once they are presented. What Charles Reich has done is to tie these together to form a diagnosis.

For instance, in discussing how Americans have lost their collective "self" Reich dwells on the school as preparation for a job in the machine. The college students needs no explanation of most of his ideas. Senseless goals are set and students are trained to obey and not to think. They have little freedom that is not given to them and are classified in a hierarchy of statutes which will greatly influence their future lives. Their life style is being determined for them. Similarly, the State has prescribed a life style for its citizens. For example, a sex life is approved only in a monogamous marriage; a political life is limited to loyalty to the State. The diagnosis is a web of restraints on almost every aspect of life.

In losing self, Consciousness II people have become "uptight" and tense. The typical cocktail party exemplifies a constraint in personal relationships and thought. They have lost such things as physical activity, adventure, and spontaineity. How has this happened? Their awareness has been dulled. Reich considers the process of substitution in which new wants are created so that new products will be consumed. Besides the obvious substitution of television sports for the real thing, money for consumer goods has been substituted for money spent on social ills. One's consciousness has been managed by the State until the world seems to be about as good as it is going to get.

What, you ask, is the "greening of America?" Mr. Reich's theory is that the State is now causing its own destruction and is powerless to stop. It can not keep the people satisfied because it cannot be controlled in specific directions. And it has begun to take away the false consciousness it has created by piercing the illusions of Consciousness I and II. Most important, the truth, when it reached people with vitality and hope, caused a new consciousness.

The State depends on willing workers and consumers. The willing consumer wants pleasure and freedom; the worker must be self-denying and hard-working. But the two, obviously, do not go together well in one person. When people realize there is a worker-consumer contradiction and when they are not expected to find work happy, they become dissatisfied. They are disillusioned upon seeing advertising that has not brought them the freedom the product promised. Youth are especially sensitive to the false promises of advertising. Thus the State generates its own rebellion--a consumer revolt. Of course, this consumer revolt has barely begun.

The State with its rigidity and subsequent repression is exemplified by Reich in the case of marijuana. Various doctrines would legalize it and legalization could pacify people. The State helps its own destruction by enforcing the marijuana laws. An even better example of the destroying of belief in the State needs no explanation: the Cold War, the defense establishment, and Vietnam were needs created by the Corporate State.

Consciousness III spread so rapidly - and appeared so spontaneously that many see it as a conspiracy. To its members, "the promise of America... somehow has been betrayed." In idealized terms, Consciousness III starts with self as the only true reality. Not selfishness, self is based on human life and nature. Each self has worth and belongs to one family. Each person has personal responsibility for what happens in the world.

Reich describes the people of this consciousness with respect to clothes (his description of bellbottoms is beautiful), career, music, and new types of communities. With respect to career, a person is free to do what he pleases as long as he can choose a career that will change with him.

Consciousness III, according to Reich, will have little future if workers or older people do not join. He states some problems with this are a lack to a model to emulate, no idea or search for self, and, as yet, little change in goals. But the middle class shares the before-mentioned dissatisfactions and each aspect of the new way of life can be seen in terms meaningful to them. Although **Greening of America** seems to be aimed at youth with its numerous discussions of the drug aspects and new forms of communities, the new consciousness can easily be modified to fit others.

The revolution will be cultural in nature. Once people's values change, existing structures such as the legal structure will work for man, not against him. "There is no need to fight the machine. It can be made the servant of man." Technology or government will not be destroyed but will serve people.

It must be left to Mr. Reich to explain just how Consciousness III will change the country, and why today's radicals can sit back and watch things get better without sit-ins or bombings. It is more important here to mention a weak point in the book. At times Reich speaks in much too general terms. For instance, he says that technology has made possible the change in consciousness because "when there is enough food and shelter for all, man no longer needs to base his society on the assumption that all men are antagonistic to one another." The new generation of privilege has been able to reject class and economic interests. Reich seems to imply that young people are living a new way of life at the expense of their parent's money. Although he mentions the work the new generation of consciousness is doing (work in the sense of a paying job) and that young people can find jobs which do not make them cogs in the machine, he has not talked specifically enough how this could happen. He has said that people could take conventional jobs and inject human values into them. But is it possible at this time for everyone to find a job in which he could express himself and not change from the type of person he is in his spare time? Can assembly line jobs fit into his picture? The reader must use his imagination to answer this.

As I have said before, **The Greening of America** is aimed primarily at young people, who will do the teaching of a new way of life to their elders. The book has a special significance

The proposition for tomorrow: Being "engineers with the goal of working for man first and the company second."

for the engineering student. If the State is built on technology which has ignored human needs, then engineering students have the potential to maintain the status quo. They can join the Army Corps of Engineers in projects like crisscrossing Florida with barge canals and flooding Allerton Park. In this they would leave it up to other experts, their superiors, to determine what is good for people. Or they can become engineers with the goal of working for man first and the company second. The choice is each person's to make alone. Recognizing the current trend of educating engineering students in liberal arts and sciences to produce more well-rounded individuals, I would recommend **The Greening of America** to all future engineers.

For the Benefit of Mankind

Excerpts from Dean Everitt's speech upon receipt of the Washington Award.

I would like to discuss tonight some aspects of the basic question, "What is enginnering and what is its mission in the scheme of things and how may we contribute to that mission?". . .

The Engineers' Council for Professional Development, which is an association of most of the major engineering societies, adopted in 1962 what is accepted as the official definition of engineering. . .

"Engineering is the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment, to develop ways to utilize economically the materials and forces of nature for the benefit of mankind."

I am most happy that "for the benefit of mankind" is considered a specific objective of engineering activity; although, our critics, many of whom have made no contributions to such an objective, say that our actions belie our words. I am convinced that more and more engineers feel that the mission of engineering is indeed to work "for the benefit of mankind", rather than for narrower objectives. . .

The meaning of the phrase in the ECPD definition was intended to be a forward step in the ethical development of the profession. It would be difficult to deny that man is motivated fundamentally by selfish drives. He works first for himself, then for his family, then for his group, his tribe, his nation. According to Darwin this is true of all species. A beaver is "beaver oriented". He does not worry if his dams flood out a forest. Civilization, a term applied only to man in organized groups, is considered to be measured by the degree to which selfishness can be held in bounds for the benefit of the group. Each enlargement of man's group interests represents moral and ethical advancement. . . .

In our engineering associations we have emphasized that the true professional must have a major interest in serving society, an interest which will transcend selfish motives. Those who accuse engineers of being interested only in their salary, and indifferent to who hires them or what they produce, allege that we have not developed the professional concept of service. I deny the allegations and I defy the allegators. . . .

At any rate, I will continue to maintain that if the engineer places "the benefit of mankind" above his petty personal interests, we will be developing a higher ethical and moral approach that most vocations have attained in the past. Devotion to this principle is the only logical way to answer the criticism now being leveled against us.

These are troubled times, in fact they have been since my boyhood when the Pax Brittanica was broken by World War I. Since that time we have never really had peace, only short pauses for enemy identification. Recently the intensity of turmoil has increased. The second law of Thermodynamics says that "confusion is always increasing and only if we work hard can we keep it down in limited regions." Nothing illustrates this better than modern music, art, and modes of dress. Particularly

in troubled times, when people are upset, they look for a scapegoat, someone to "blame it on." The current scapegoat is Technology, a term which includes not only engineering but all forms of the applications of science to the needs of man, including modern agriculture and medicine. . . .

There is, currently, a plethora of books being published, lectures being given, and conferences being held which say in effect "blame it on technology, it is the culprit. Technology has put man in bonds from which he must escape. Return to the simple life."

I am inclined to admit to the charge that the level of civilization in a country is indicated by the degree of helplessness which results when the power goes off. However, I believe that much of the criticism is due to a misunderstanding of what technology really is, of what it has done, and what it can do, "for the benefit of mankind." But our critics sometimes present impressive academic and literary credentials which are being accepted by much of the general public as making them experts. Three of the most widely read analyses are "The Greening of America" by Charles Reich, which, for some weeks, has been at the top of the nonfiction list, "The Pentagon of Power" by Lewis Mumford and "Future Shock" by Alvin Toffler. Each suggests escape through the renouncing of the parts of technology they dislike and the development of forms of Utopia, each of their own devising.

Life in these Utopias will still depend on the productivity of some portion of society which they fail to identify. *Time* says of "The Greening of America" that "Reich contends that Utopia has all but arrived, its insignia evident everywhere in the dress and song of youth, in its language and gesture. The rest of the population has no choice but to fall in line and enjoy the inevitable triumph of Consciousness III." (This is Reich's term for his brave new world.) Consciousness I represents the attitudes of the early pioneers. Consciousness II is that of those in sympathy with the modern industrial state. (That means us.)

Samuel McCracken, assistant professor of literautre and humaniites at Reed College, reviews the same book in, *Change,* the Magazine of Higher Education, a review which he terms "The Fuzzing of America." (note: he is a humanist and not an engineer.) McCracken says of Greening:

> "The argument lies jellied in an aspic compounded about equal parts of vulgarized Marx, uncritical admiration for just about every behavioral fact of the times and nerveless intellectual irresponsibility stiffened by a compulsive inconsistency which must be experienced to be believed.". . ."Conscousness III neither wants nor needs higher education.". . ."The most striking quality of the book is a pervading inconsistence interpretable either as a symptom of intellectual confusion or as the tactic of a clever lawyer defending a generation before a jury with a very short memory.". . ."Reich is a humanist at odds with humanity."Anything resembling modern medicine requires not only the theoretical existence of a technology but a supply of type I and II rationalists who wish to be doctors and who may well wish to lead type I and II lives."

Incidentally how far would Reich or Mumford be without one of the greatest developments of technology, the techniques of printing and distribution of the mass media. . . .

In all these books there is an approach of the type described by Professor McCracken as:"The pattern is not very original, whatever one likes--on other grounds--and one may plausibly call natural, one calls natural, whatever one dislikes on other grounds--and one may plausibly call artificial, one calls artificial. Whatever exists, one may plausibly call natural: whatever man makes, artificial.". . .

No engineer will claim that technology alone can solve the problems of the nation or the world. However, they cannot be solved without an understanding and effective application of modern engineering methods, particularly system analysis. They will not be solved if engineers as a group do not also have a broad understanding of social problems and forces. . . .

It is generally agreed that our future will call for a reorientation of many of the goals of society. Engineers alone cannot determine what these goals will be, but they can have great influence on what choices will be made, if they use their informed knowledge to present, in clear and simple language, the alternatives which technology make possible, together with the identifiable costs of these alternatives both in money and quality of life. Many of the goals society now seeks will be costly, costly, both in money and in the sacrifices of other desirable values. Some of the costs may involve the acceptance of a reduction in individual freedom of action in order to serve the needs of the many. Here is an opportunity for an educational endeavor of great potential. . . .

If engineering is to function "for the benefit of mankind" it must make the choices and the costs clear to the citizenry so they may more knowingly participate in settling the many issues which will involve technological alternatives

Engineers like to work with what they understand, but if they do not understand the necessary components fully they will not say that a solution is impossible. Even today we do not really understand the macrostructure of steel and concrete and must depend upon empirical tests to get the data used in the design of buildings, bridges and machines. But science is giving us greater understanding each year and permitting the design of devices like transistors, lasers and polymers which intuitive reasoning and empiricism would never have made possible.

An area in which we are presently groping and see only "as through a glass, darkly" is that of systems analysis. And it is here that I see great promise for the future. We have both new understanding, a new device of great potential, the computer, and a new modeling technique which may help us to predict more accurately the effect of proposed changes in our urban society. . . .

Now the engineering concept known as "feedback" is almost a household word. It is in the daily vocabulary of economists, biologists, writers, and ecologists. The idea of modeling economic systems is also well accepted. Modeling is a technique in which engineers have been leaders. . . .

Take one example of feedback in the city. Sociologists may promote programs to construct low cost housing to help underemployed in a particular city. But what happens? The rise in this type of housing attracts more underemployed to the city. The construction also uses up available land and makes the area less attractive for worker and premium housing. As a result enterprise and business decline, the jobs available decrease, unemployment rises, and the city is worse off for its efforts. . . .

Our most pressing problems seem due to the growth in population. If technology is to blame for this it is because infant mortality has been reduced and the mortality due to diseases common to later life have also been decreased. Who is willing to come out for a reversal in this trend? But with increased population has come increased pollution. Obviously the answer to pollution can only be obtained by more rather than less technology, together with the national reorientating of priorities and goals which is beginning to emerge.

There is another important phrase in the ECPD definition of engineering. It is "applied with judgment." Judgment is a dynamic ability, it must necessarily change with times and knowledge of current conditions and a look into the future. Judgment depends upon knowledge and wisdom. Wisdom is the ability to use knowledge, hence it cannot be developed in the absence of knowledge, although some of our modern student curriculum revisionists think it can be achieved by just talking among themselves in unguided seminars. . . .

The wisdom available today cannot remain static and fulfill the needs for the wisdom of tomorrow. New wisdom must be based on new knowledge. The future educational program for the engineer will require a lifetime of involvement. Engineering is not merely a learned profession, it is a learning profession a calling whose practitioners must first become and then remain students throughout their active lives.

The failings of the young

William L. Everitt (center), dean emeritus of the College of Engineering, receives Washington Award of the Western Society of Engineers from William A. Baxter (left), president of the society, and Frederick G. Jaicks, chairman of the award committee.

Picture courtesy of University of Illinois Office of Public Information.

GROWN MEN SHOULDN'T

Soon tests will begin on a bright idea for roofing stadiums with stainless steel balloons. And nickel's helping make it happen.

It sounds like something out of Jules Verne. Actually, it's fresh out of our advanced design studies.

A gigantic, *inflatable* metal lid that can be stretched across a football stadium without any pillars or posts of any kind.

The idea is so mind-boggling that most people have a hard time visualizing it.

Think of a pie that's hollow inside, with the bottom and the top made of a metal skin only 1/16th of an inch thick. When the air is pumped into the pie, the whole thing gets so rigid it can be jacked up into place over the field and never even flutter during a windstorm.

The weather stays outside, the players don't slide around on their backsides, and the spectators don't drown. Somehow, the whole thing seems a little more civilized than a public mud bath.

And the cost could be as little as 1/3 of a conventional trussed roof.

are usually because they don't know the answers. The turkey that runs to his feeder isn't stupid, he just doesn't know about Thanksgiving. Engineers also may not know the answers but they will have to find and propose solutions for the problems of society with knowledge which they must yet acquire. As problem solvers by profession, they should expect difficult problems under new situations. These problems should not be met with the continual cry of crisis-crisis-crisis so common today. Repeated cries of alarm produce only the well recognized reaction of the old fable of wolf-wolf. The conception of "crisis" implies that it is a situation to be approached with fear and trembling, almost inevitably accompanied by a sense of helplessness and frustration. Let us barbeque our wolves and get about our business.

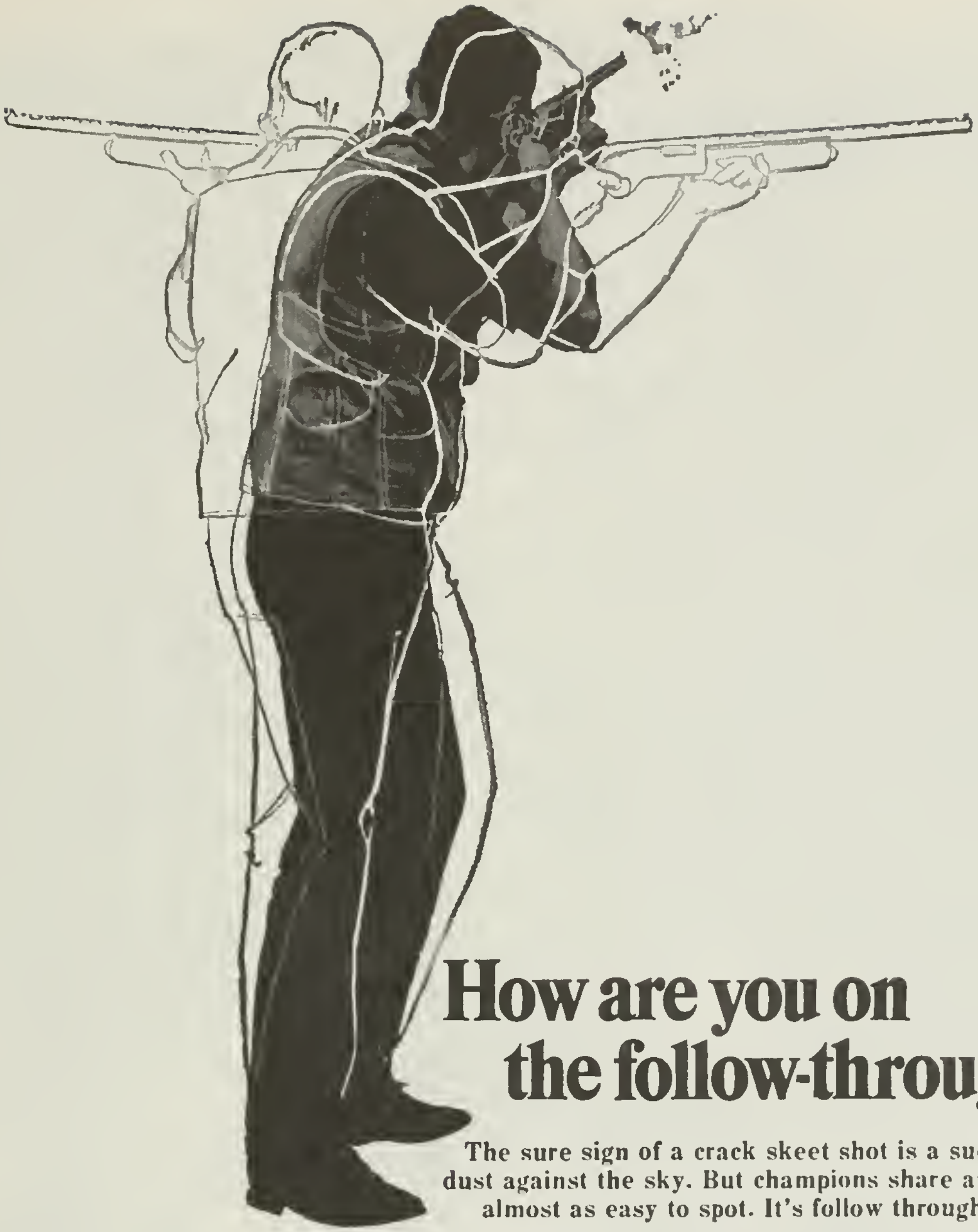
For too long we have planned our educational structure on the concept that education is primarily for the young. I do not believe current programs for continuing education will serve the needs of the future adequately. In fact, they may well dissipate efforts which could better be applied in other directions. Engineers need education characterized by both breadth, in order to communicate, and depth, in order to contribute. Experience has shown no curricular revision can achieve this in the time available to current undergraduate and graduate programs.

While an engineer should expect to participate in a lifetime of hard work, as well as intellectual activity, he cannot be most productive if his employer assumes the needs for intellectual development are solely the employee's responsibility, to be taken out of the hide of the individual. In the future, the demand that industry must also function "for the benefit of mankind" will require that they must accept the fact that a part of the cost of doing business will be to release time, and appreciable amounts of time for their professional staffs, engineers and others, to engage in intellectual rejuvenation. . . .

In December, at the time of the meeting in this city of the American Association for the Advancement of Science, the 1965 recipient of your Washington Award, Dr. Glenn T. Seaborg, Chairman of the Atomic Energy Commission and president elect of the AAAS was scheduled to make an address. He was prevented from doing so by self designated representatives of the movement to suppress Technology, who were also aggressively opposed to the exercise of Freedom of Speech. Portions of what might be termed Seaborg's Unfinished Symphony were published in the press and I think are pertinent to my theme tonight. I wish to quote from them:

> "It is easy to lay blame for the world's turmoil on science and technology by saying their work has given us a world we never bargained for.
>
> But it is also, I feel, a world that will force us to change for the better, to evolve to a higher order of life that will be able to establish a new harmony with its environment as well as a new degree of stability within itself, in other words, live in dignity and peace.
>
> I think the coming years will see science and technology talking back to its critics and speaking in actions that prove they are doing far more than righting past wrongs and adjusting the inbalances caused by man's technological excesses or indiscretions."

As engineers, let us not merely assert that our profession is devoted to "the benefit of mankind", but by our actions and relations with our fellowmen in all fields of endeavor, demonstrate unmistakably and irrefutably that this is both our purpose and our capability.



Galvanized Steel Bridges save the taxpayers dollars—

ZN 461

This new 900 foot long bridge is the latest example of the trend to maintenance-free galvanized steel bridges. It is the Hauterive Bridge over the Manicougan River, 250 miles north of Quebec City, Canada. Because of its relatively remote location, designer Emile Laurence gave special consideration to the taxpayers maintenance dollar. He specified a zinc overcoat to protect the bridge against corrosion and also avoided possible damage from tall loads by eliminating any upper wind bracing. The designer placed the deck higher than usual—approximately 14 ft from the lower chord. This made it possible to use very deep bridging to insure stability. The composite deck also acts as wind bracing, supplementing the stiffness provided by the horizontal bracing at the lower chord, so that the whole acts as a tubular truss. Most of the steel was hot dip galvanized while other members were metallized with zinc. In bridges and guard rails, steel's strength guards human life and zinc guards steel's strength against corrosion.

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You and Honors Fraternities

by Halvard Nystrom

If instead of finding the **Technograph** in your mailbox, you might find a letter from some fraternity (you would know by their greek letters), perhaps you would think, "What would they want with me?" You would open it and read:

> Dear Engineering Student:
>
> In recognition of your high scholastic achievements in the. . .you will be considered for membership in AXY. . .The financial cost for joining AXY is________... A pledge meeting will be scheduled for________...
>
> Sincerely,

What is all this about? You have just been invited to join an honorary fraternity. Most students never have to worry about joining one, but what if you did receive a letter like this. Would you join? Is it worth it for you? Let's take a look.

As defined by the Association of College Honor Societies, an Honor Society is primarily an association of collegiate members and chapters whose purposes are to encourage and recognize superior scholarship and/or leadership achievement either in broad fields of education or in the departmental fields at undergraduate or graduate levels. The activities that generally take place by most of them are: a pledge meeting or two, an initiation banquet, and a meeting for election of officers. Besides these, individual societies may sponsor picnics, bowling tournaments to help student-faculty relations, organize review sessions for the E.I.T. exams, or recognize problems such as pollution and attempt to do something about them.

Now let's look a little more into the practical aspects of why you should join an honor society (or fraternity). You would want: 1) to receive some recognition for your scholastic achievements; 2) to serve this messed up world in some way; 3) to help your grades by impressing your instructors by your membership; 4) to help in getting a job by impressing the interviewers; 5) to be associated with students with similar achievements and perhaps stimulate your studying a bit; 6) to be associated with the faculty members, especially the faculty advisor, and maybe even get to know them well; and 7) to be informed as to the happenings in Engineering through the meetings and the publications.

So you think that the reasons sound pretty good. But, are there any reasons why you would not want to belong to an honor society? 1) Not many people find out about the members of the honorary fraternities, and at least by our own peers, membership in one is really not very impressive. 2) Interested individuals have an opportunity to be of service, but most activities of the honorary fraternity members consist only of the pledge meeting, banquet, and officer election. Because most members do so little, the effect of their membership is really insignificant even to themselves. 3) Many instructors never find out about fraternity membership, and even if they did, they are rarely impressed enough to raise any grades. 4) Job interviewers know what the average significance of membership is. Usually they will not be too impressed since they will see the applicant's grades anyway. But maybe the interviewer belonged to the same fraternity and perhaps he will choose one individual over other applicants because of this coincidence. The odds are slim, but nevertheless, he may get a job because he joined a fraternity. 5) If one does not actively participate in group events, he will not be associated, to any great extent, with the students of similar caliber nor any of the faculty members, nor will he learn much of what is happening in Engineering. 6) It costs money —usually around $30.

So, the final decision is merely weighing the advantages and the disadvantages. Are the benefits worth the cost? Will your membership in AXY make you a better person and thus capable of doing more for others? If you might be invited to more than one fraternity, will you join all of them?

To help you out in your decision, below is a table with all the engineering honor fraternities on campus. From their requirements you can get some idea about which frats, if any, might ask you to join. If you are asked to join a particular fraternity, you can find out: 1) how much it costs, 2) if it does much other than have the basic meetings, 3) whether there are any initiating rituals that you may not like or that may help you get closer to the other members, and 4) how its reputation is outside the university.

Finally, although honorary fraternities have something to offer, they are not the only groups around. If you are really seeking an opportunity to do service to the community you might investigate service organizations that are better suited to your expectations.

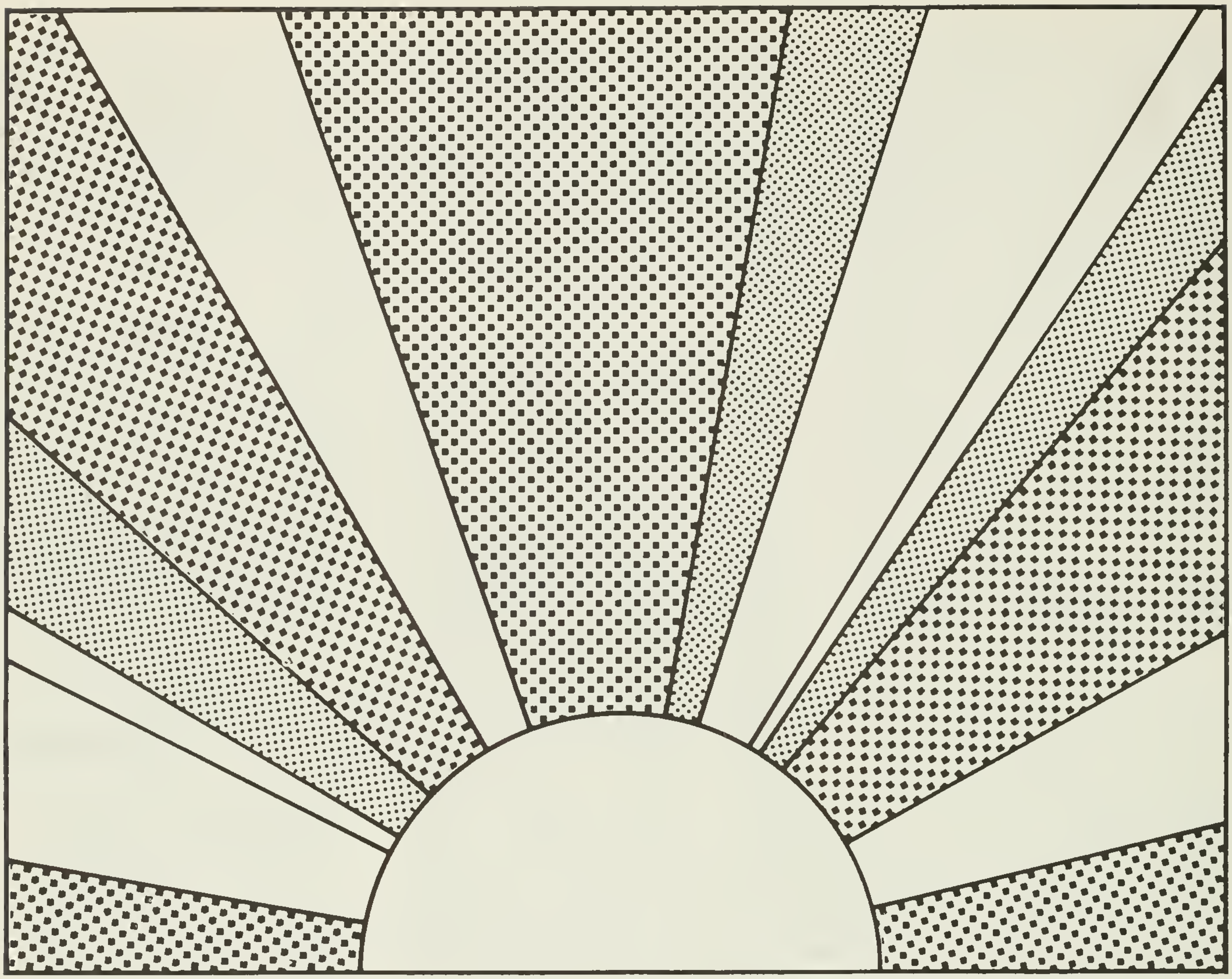
Good luck.

CAMPUS HONORARY ENGINEERING FRATERNITIES

Name	Field	Requirements			Total Membership
		Jr-1	Jr-2	Sr *	
Alpha Epsilon	Ag. Engr.	4.00 (1/4)		3.80 (1/3)	629
Sigma Gamma Tau	Aerospace Engr.	4.3 (1/8)		4.0 (1/5)	6,134
Keramos	Ceramics Engr.	4.0	3.75	3.5	
Phi Lambda Upsilon	Chemical Engr.	4.3		4.5**	
Chi Epsilon	Civil Engr.	4.0 (1/3)			24,237
Eta Kapp Nu	Electrical Engr.	4.5 (1/4)	4.2	4.0 (1/3)	64,120
Sigma Tau	Engineering	4.25		4.0	
Tau Beta Pi	Engineering	4.75 (1/8)	4.5	4.25 (1/5)	150,000
Gamma Epsilon	General Engr.	4.1	4.0	3.9	
Pi Tau Sigma	Mechanical Engr.	4.25 (1/4)	4.0	3.9 (1/3)	42,000
Alpha Sigma Mu	Metallurgical & Mining Engr.	(1/4)			2,319

*Entrance requirements vary accordingly with your scholastic standing. That is, it is easier to get into a said fraternity in your senior year than in your second semester junior year (Jr-2) or first semester junior year (Jr-1). Requirements are given (when available) in both rank in the field and grade point average.

**Graduate students' requirements



Guaranteeing clay pipe is like guaranteeing the sunrise.

Our 100 year guarantee* on clay pipe is almost unnecessary. Because clay pipe's durability is as certain as the rising sun.

Aren't we overstating our case a little?

Not at all. Clay is one of those rare substances that nature made virtually incapable of being corroded or chemically broken down.

Clay is formed after sun and rain and sleet and snow have beaten away at the earth for thousands of years. When the earth's crust can't be broken down any further, all that's left is a layer of virtually indestructible material. Clay.

Of course, nature doesn't work cheaply. So clay pipe costs a little more than pipe made of cement bonded materials or synthetic plastics.

But what a difference in performance. While you can expect other pipe to last about 5 or 10 years, clay pipe has continued serving in wastewater systems all over the country for generations without any kind of breakdown.

That's why makers of other kinds of pipe seldom guarantee their product for any specific length of time, while we guarantee clay pipe for 100 years and know it's an understatement.

If you want to make sure the pipe in your wastewater system lasts, make sure it's clay. The toughest pipe material under the sun.

W. S. DICKEY Clay Manufacturing Company
Kansas City, Missouri; St. Louis, Missouri; Lehigh, Iowa; San Antonio, Texas; Birmingham, Alabama, Meridian, Mississippi; Texarkana, Texas-Arkansas

*Dickey Clay will supply—free of charge—replacements for any clay pipe which has been damaged, destroyed or impaired in service for a period of 100 years from contract date, if damage has been caused by corrosion or other chemical decomposition from acids, alkalis, sewage or industrial wastes (except Hydrofluoric Acid) or damage by rats or other rodents whether pipe is used for industrial, residential or general drainage purposes. Damage from improper handling, placement or trench loading is not covered.

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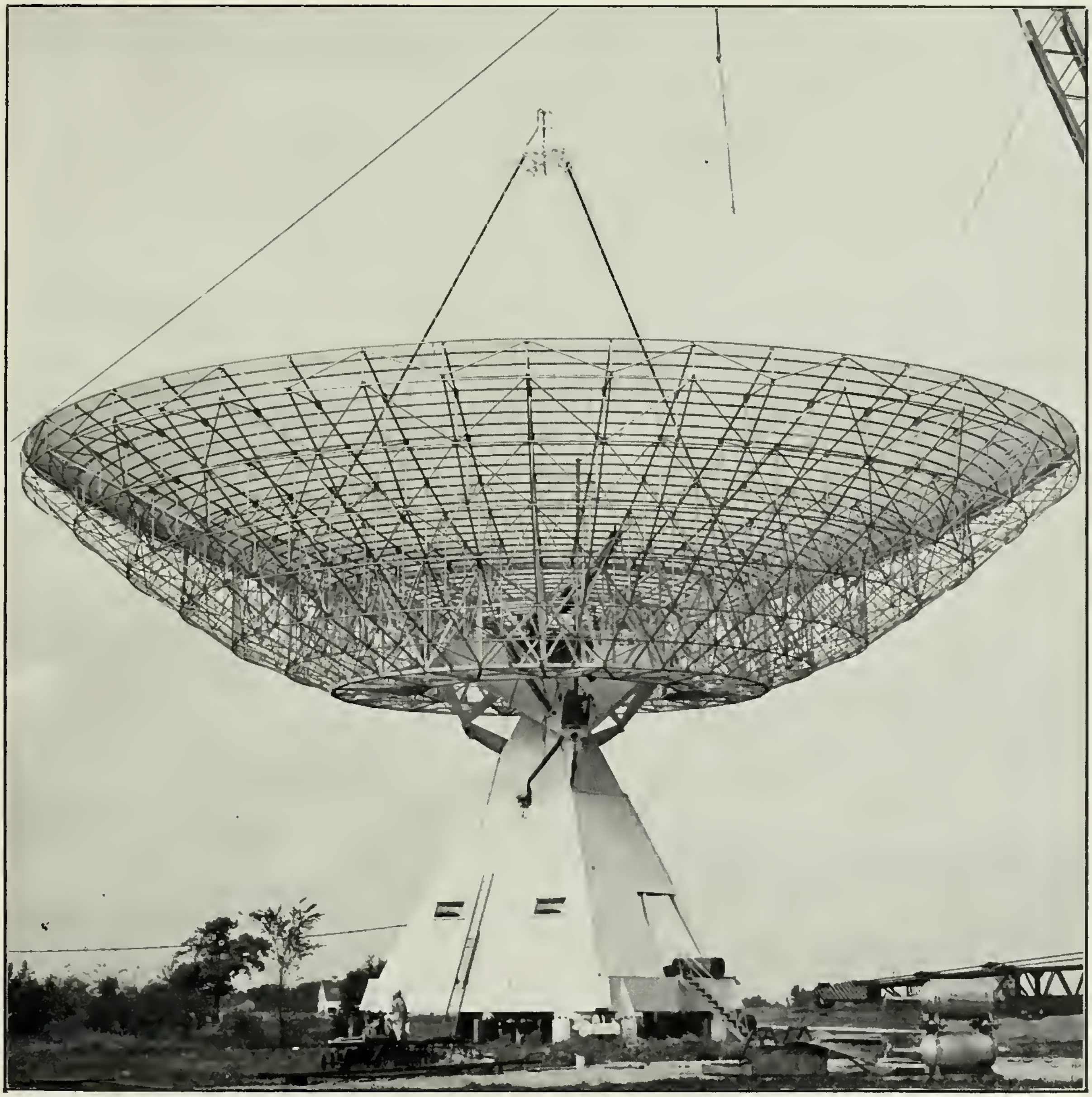
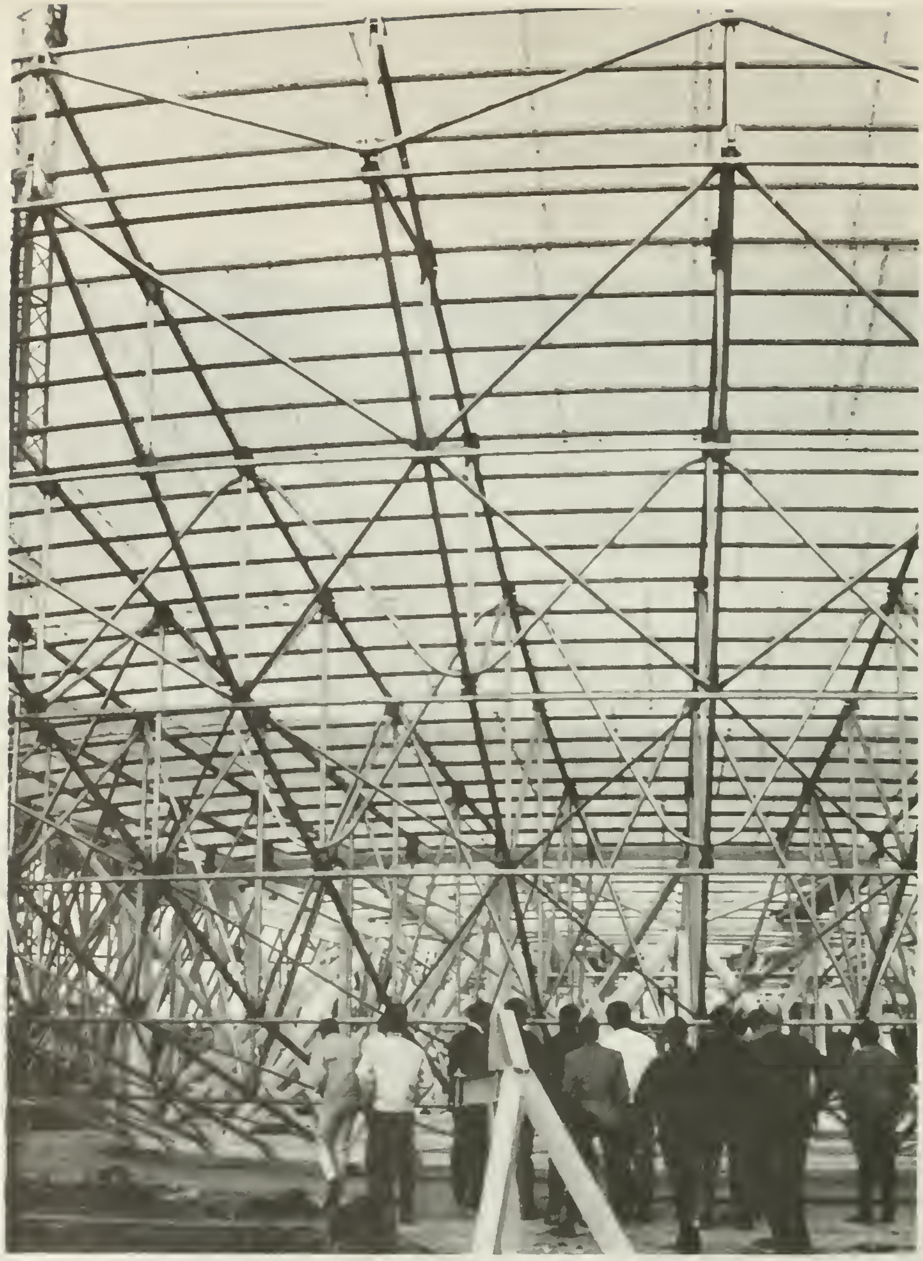
TECHNOGRAPH



OCTOBER, 1971

University of Illinois

We keep the news fit to read.



Homemade Ear Listens to Stars

by Benny Sieu

At the University of Illinois' Vermilion River Observatory, located 45 miles east of the Urbana campus, stands a 120-foot radio telescope that was entirely "homemade".

A group of approximately 25 professors, engineers, technicians, and students began construction on the telescope in 1967. A majority of the students were undergraduates working as laborers and technicians during the summer and weekends.

The original plan was to construct three radio telescopes, but dwindling federal and state research funds resulted not only in the suspension of plans for two telescopes, but prohibited the employment of private contractors to build the third. It was then decided that the observatory staff should build a radio telescope of its own.

Tools and machinery needed to construct the telescope were acquired from government surplus stocks. The 120-foot radio telescope was designed by Neil Stafford of the Stanford Research Institute, Palo Alto, California, and the detailing of his design was done by Arno H. Schriefer, an observatory staff member.

"By and large, everything went together very smoothly and I think it is a testimonial to the design supplied to us," says Professor George W. Swenson, head of the astronomy department and director of the Vermilion River Observatory.

The large paraboloid dish consists of a central structural-steel hub from which 60 cantilevered aluminum trusses extend outward and inward. These trusses support 40 concentric aluminum hoops carrying the reflecting surface. The reflecting surface is a lightweight expanded aluminum mesh.

A 190-foot guy derrick, borrowed from the government and overhauled by the staff and students, was used to set the 40-ton dish atop the base pedestal. The pedestal, weighing about 50-tons, consists of large steel pipes welded into a pyramid. Bolted beneath each corner of the pedestal's square base are 1,000 cubic feet of reinforced concrete blocks. This enables the telescope to withstand winds up to 100 miles per hour when it is stowed in the zenith-pointing position; that is, with the dish pointing directly overhead.

The receiving antenna is placed at the prime focus of the dish. Located at the apex of the support tripod are the electronic housing and concentric feed antennas. Should these parts need servicing, a worker must climb a leg of the tripod to the apex and hope that his hands are steady.

The roller chain drive machinery operates on essentially the same principle as a large bicycle chain. A 3-horsepower induction motor is used to drive the roller chain sprocket at a pace that is synchronous with the earth's rotation, enabling the equatorially mounted telescope to track a radio source in sidereal motion.

To move the telescope to new positions as part of a radio interferometer, jacks are used first to raise the telescope off the concrete piers on which it rests during observation sessions. The telescope can then travel on a couple of double-flanged crane wheels over a monorail system.

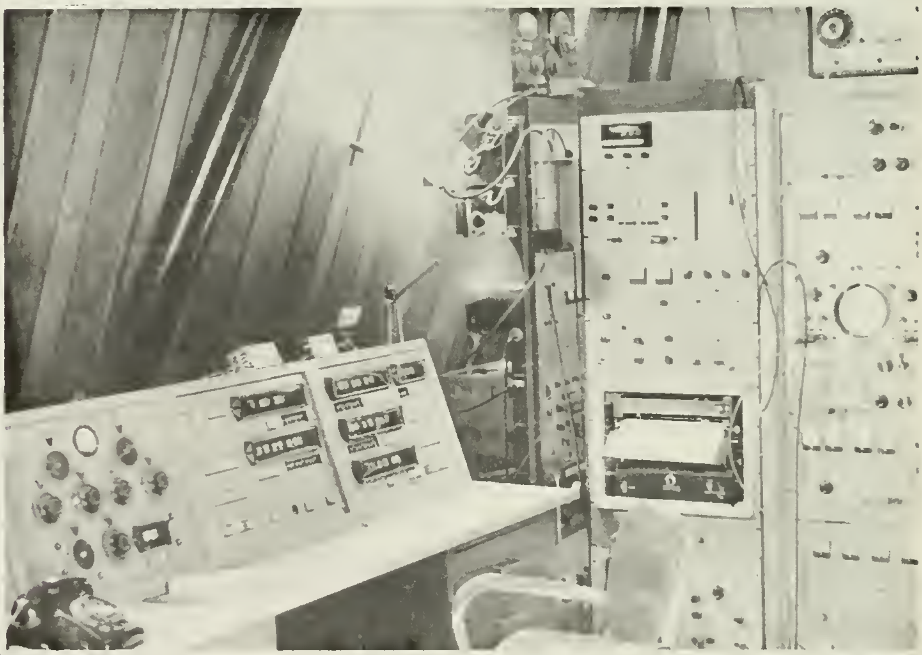
At the focus of the 120 foot dish antenna, the five foot tall instrument package collects the reflected signal.

Most of the statistical data taken from the telescope is in the form of graphs or memory bits on computer tape from the telescope's instrumentation.

The 120-foot telescope's greater versatility and flexibility compared with the older 400-foot telescope at Vermilion River Observatory is demonstrated by the newer telescope's ablity to follow sources across the sky in both the north-south and east-west directions, whereas the older telescope can be steered in only the north-south direction. The 120-foot radio telescope can be used for longer time periods, which are required for certain investigations. The smaller telescope is also more precise. It may be used at wavelengths as short as ten centimeters. The construction was mostly completed in late December, 1970 costing 50 per cent less than an equivalent, contractor-built radio telescope.

The primary research observations were to set up a long baseline interferometer. Interferometry is a technique used to determine the exact location and size of radio sources. Two antennas, separated by a large distance, are used to receive the radio emission. These antennas are connected to the common input of a radio receiver and the variations in signal strength at the output produces interference patterns. Since these patterns are dependent upon the angle subtended by the radio source, its position can be found. Interferometry can also be used to determine the effective diameters of radio sources with an accuracy of one-one thousandth second of arc by measuring the ratio of the maximum and minimum signal at different antenna spacings.

The other telescopes used to carry out the primary research observations were a 130-foot Cal Tech telescope in the Owens Valley of California and a 150-foot Naval Research Laboratory



TOP: During the construction phase the dish and the four-sided pyramid base were assembled separately. Note the monorail which allows the entire telescope to be moved between observations.

BOTTOM: Inside the completed pedestal the master control board of the telescope allows the operator to monitor both real and sidereal time and to check the coordinates of the telescope's position. In the background are the receivers and recorders as well as associated test equipment.

Clay is dead. Long live clay pipe.

Clay makes the longest lasting pipe in the world. And all because of one important physical property: chemically speaking, it's dead.

Clay has no stored energy so it's virtually indestructible. Other substances tend to expend their stored energy until they're chemically at rest. And, as any material gives off energy, it breaks down chemically.

Since clay is already at rest, there's practically nothing that can corrode it or weaken it. So you can find clay waste systems all over the country that have been going generation after generation without significant wear or corrosion.

And you can get a 100 year guarantee*on clay pipe from Dickey Clay while makers of other kinds of pipe never seem to guarantee their product for any definite length of time. Best of all, Dickey has added to the natural wonders of clay pipe with a patented urethane joint. One that keeps the entire wastewater system bottle tight even under the most extreme conditions, for the life of the system.

We don't mind telling you that clay pipe costs a little more than other kinds. We don't mind because the cost of pipe is only a small fraction of the cost of a wastewater system . . . and the additional cost of clay pipe is so small that the effect on the total cost of the system is minimal. Yet that minimal extra gives you the only kind of system you can depend upon to be permanent.

When you want to be sure, specify Dickey Clay pipe. Your waste disposal system will rest in peace.

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ENGINEERS GUIDE TO COMPARATIVE VALUES

IN ZINC vs. PLASTICS

Unreinforced Plastic vs. Die Cast ZINC*

Material	RATIO OF COSTS FOR EQUIVALENT LEVELS OF VARIOUS PROPERTIES					
	Tensile Strength at 24°C	Tensile Strength at 80°C	Flexural Strength at 24°C	Tensile Creep (100 hrs.) at 24°C	Un-notched Tensile Impact Strength at 24°C	Flexural Fatigue Strength at 24°C
ABS	2.54	3.46	1.37	12.3	2.78	0.91
Nylon 6/6	4.72	5.40	2.70	85.6	1.64	1.91
Polyacetal	3.09	5.00	2.40	29.0	3.60	1.42
Polycarbonate	3.82	3.60	2.33	20.0	1.70	3.40
Polypropylene	2.00	3.13	1.10	37.7	1.09	0.52

***SAE 903 Die Cast ZINC = 1.0**

****Costs as of January 1970, (carload lots or maximum quantity bracket). All calculations are based on these figures.**

Glass Reinforced Plastic vs. Die Cast ZINC*

Material	RATIO OF COSTS FOR EQUIVALENT LEVELS OF VARIOUS PROPERTIES										
	Tensile Strength at 24°C	Tensile Strength at 80°C	Tensile Stiffness at 24°C	Tensile Stiffness at 80°C	Flexural Strength at 24°C	Flexural Strength at 80°C	Flexural Stiffness at 24°C	Flexural Stiffness at 80°C	Tensile Creep (1000 hr.) at 24°C	Notched Tensile Impact Strength at 24°C	Flexural Fatigue Strength at 24°C
Gl. Re. Nylon 6/6	1.91	2.68	8.42	8.90	1.82	1.91	20.5	16.7	7.85	3.83	1.96
Gl. Re. Polycarbonate	3.36	2.68	10.0	5.27	2.56	2.05	20.4	3.05	5.46	9.24	2.88
Gl. Re. Polyacetal	4.73	5.40	12.7	11.1	4.20	3.78	26.4	5.04	9.45	20.9	2.81
Gl. Re. Polypropylene	2.83	2.74	5.26	11.4	2.48	2.39	13.1	6.30	6.51	13.2	1.69
Gl. Re. Polysulfone	4.00	3.21	12.7	6.66	3.39	2.78	23.7	5.44	4.83	16.5	3.76
Gl. Re SAN	1.63	2.14	4.37	2.78	1.70	1.49	9.70	1.84	1.90	10.1	1.14

***SAE 903 Die Cast ZINC = 1.0**

****Costs as of January 1971, (carload lots or maximum quantity bracket). All calculations are based on these figures.**

ZN-495

These charts are based on information from two extensive engineering evaluations conducted by U.S. Testing Co., for the International Lead Zinc Research Organization Inc. These studies showed that in almost every instance die cast zinc gives you more performance for your money than any of the plastics tested. ☐ For example, the results showed that an unreinforced Polycarbonate rod would cost 3.82 times more than a SAE 903 rod to withstand the same tensile load. Glass reinforced Polycarbonate would cost 3.36 times more than zinc. ☐ Reprints of this "Engineers Guide" are available. Just let us know the quantity you would like.

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Research Open to Undergraduates

With one of the largest engineering research programs among the nation's universities, Illinois offers a great opportunity for engineering undergraduates to gain a hand-shaking acquaintance with their profession. Any student can be a research assistant, and the chances of getting on the project he wants to work on are very good, with the right approach.

Necessarily, the student would not be involved in critical areas of any research when considerable knowledge would be required. The 20 undergraduates on the radio telescope project worked mainly as machinists, and not as designers. But, whatever your role, you will become a little more acclimated to engineering, you may meet a few more professional people than otherwise, and you will learn something from you experiences. Working on projects like the radio telescope or PLATO certainly adds dimension to regular class work.

How do you get on the project you are interested in? See the project director, tell him you have heard of his research, that you are very, very interested in it, and that you would very, very much like to work with him. Tell him you will do anything—sweep floors, type, make coffee—anything to get on the project.

Supporters of this "enthusiastic" approach report they have yet to see it fail, and that you may even get on the payroll after working a while.

How can you learn what research is currently being done? Your best source is probably your advisor. Too, he knows your academic background and interests better than anyone else, and will be better able to advise you.

Whatever, you will have to talk to people for information. Very little material is ever published concerning a project until the project is completed. A good overview of recent research on campus is **The Summary of Engineering Research, 1970.** Free copies are available from the Engineering Publications Office, 112 Engineering Hall.

telescope in Sugar Grove, West Virginia.

Precise atomic clocks were used to accurately synchronize the instruments. A small wired-program computer used for indicating the angle of the radio source was designed and built by the observatory staff. It not only indicates the total angle and counts the number of pulses, but also provides safeguards for the operator's controls to prevent blunders or accidents. Should the computer fail, the telescope can be controlled mechanically if the motor still has power.

The 120-foot radio telescope is also used for studying strong radio emissions from some puzzling phenomena of the universe. These include pulsars, small dense objects which emit precise periodic bursts of radiation; quasars, bright, starlike objects located at the farthest parts of the universe; and radio galaxies, which were first thought to be colliding galaxies. Variations in the time of pulses, strength and wavelengths of these sources are recorded.

The recent discovery of complicated organic molecules in the massive clouds of dust and gas that saturate the Milky Way has resulted in plans to use Illinois' new telescope as a sensitive microwave spectrometer. A spectrometer was designed by the observatory staff to be built by the chemistry shops. Although radio astronomers have yet to detect amino acid clouds, organic molecules such as methyl alcohol and formamide have been detected.

As in most areas these days, the astronomy department is experiencing a financial crisis. Budget cutbacks in state and federal funds stopped operations of the department's older and larger 400-foot radio telescope more than a year ago.

The department received a National Science Foundation grant which will provide $154,000 for the current year although the department asked for a minimum of $176,000. Other factors contributing to the department's financial woes are fewer individual NSF research grants, lack of cost of living raises for the faculty, and the increased cost of publishing research results in scientific journals. As a result, future research utilizing the 120-foot radio telescope may also be curtailed.

Barnacles. They're uninvited—and expensive. So a new hull is being tested that could keep them at bay. And nickel's helping make it happen.

Shrimp boats are a-comin'—out of a harbor at San Juan del Sur, Nicaragua. And one of them is unlike any other work vessel in the world.

It has a new kind of experimental hull designed to fend off barnacles and other drag-producing marine growth *permanently*.

The Copper Development Association, sponsor of the project, estimates that the new hull material could reduce fuel consumption by as much as 15 to 20 percent. And, by totally eliminating hull scraping and painting, could slash maintenance costs up to 80 percent.

Most impressive of all, though, may be the savings that come through improved efficiency. At present, for example, a slowdown of even one knot because of bottom-fouling can cost a big tanker as much as $4,000 a month. And the loss of five profitable working days for a layover in drydock can mount up to $100,000 or more.

Test boat with copper-nickel hull.

A View of Engineering at Illinois

ME and EE Students Team to Build Clean Air Vehicle

Two groups of engineering students are presently involved in the designing and building of an emission-free car to compete in the Clean Air Car Race next year.

Fifteen electrical engineering students are designing the electrical drive and the accompanying switching circuits for credit in EE 272. Between ten and fifteen mechanical engineering students are designing the drive systems, the engine, the suspension, and other components for their senior projects. The target date for completion of both halves of the project is Easter vacation.

The three-phase, AC motor which drives the wheels will be energized by two interchangeable power sources. One source is a nickel-cadmium battery and the other, a generator, powered by an LP gas-fed Wankel-type engine.

Keith Erickson, graduate student in Labor and Industrial Relations, is the project director. Electrical Design Coordinator is Bill Burtness, senior in Electrical Engineering. Tom Quaka, senior in Mechanical Engineering, is the Mechanical Design Coordinator. The two faculty advisors are Roger Burtness, electrical engineering professor, and Dan Metz, a general engineering professor.

Interested persons should call 333-4222, 333-3556, or room 27-MEB.

URBAN VEHICLE
DESIGN GROUP

UVDG'S new emblem above comes with a fresh descriptive slogan. "low pollution, small, safe, and economical. . .a new kind of animal."

Economical PLATO System Planned for UI

Last April, the University of Illinois announced a contract with Magnavox Systems, Inc. of Urbana to make 10 consoles for the PLATO IV system with an option for 250 more. The PLATO system has been developed over the past five years by Prof. Donald L. Bitzer, director of the UI Computer-Based Education Research Laboratory.

The consoles feature two devices developed at the UI. These are the plasma display panel, which is being manufactured by Owens - Illinois Glass Co. in Toledo and should cost less than $1 an hour to operate, and a device which selects one of 256 images on a slide to project.

The consoles feature sound devices which were also developed at the university. This unit can select from over 2,000 messages, including foreign sentences and music.

Present plans include a system of 4,000 consoles hooked by telephone lines to a central computer. The system would include programs for all levels of instruction, grade schools through graduate study.

The university has also developed a language called "TUTOR" which permits persons with no computer experience to prepare PLATO lessons. The program plans to place the 250 systems on campus soon and the other 4,000 in schools by 1974.

Students Design Sleep-Learning Device

This summer several UI students responded to a suggestion by Prof. L. D. Metz in a general engineering class by designing and building an electronic "sleep-learning" device. The device, called "E.A.S.E." (Electronic Aid to Somnolescent Education) consists of a lesson recording, speaker, timer, tone generator and pushbutton.

The timer is set for about 1½ hours before the subject is scheduled to wake up. At that time, it sounds an "alarm tone" which the subject must answer by pressing the appropriate button on the console. The lesson then begins and continues for a half-hour. At five minute intervals, during the lesson, the subject is asked to press the console button again to signal that he is listening. If he doesn't respond, the "alarm tone" again sounds and the subject must press the button before the lesson will continue.

Since the subject is not really asleep, but really in a semi-conscious or groggy state, the program is not really "sleep-learning," but rather, instruction at a time when the subject is very susceptible to retaining information, according to one of the project's leaders, Tom Burke, junior in General Engineering.

James Riley, senior in Electrical Engineering, designed and built the circuitry involved with the device from specifications given him by the group.

Last spring, the group contacted Prof. Roseland D. Cartwright, psychologist and director of the Sleep and Dream Laboratory at the UI Chicago Circle Campus. Prof. Cartwright was able to give the group sleep and dream information as it related to learning. She stressed that the subject would retain more of the lesson if he were returned to dream sleep after the lesson was completed. This is one of the reasons that the group eliminated an alarm-type signal to arouse the subject. They felt that this would wake him so thoroughly that he might not return to dream-sleep afterwards. Prof. Cartwright also believes that the person should feel no loss of sleep in the morning after the lesson. The group will test her theory.

The project has been underwritten by a $150 grant from the Bodine Fund, which supports special student projects in the College of Engineering. The fund is supplied by the Bodine Electric Co., 2504 W. Bradley Place, Chicago.

Tom Burke, co-designer of EASE, tests the operation of the recently finished sleep-learning device.

Also involved with the project are Greg Boysen and Patrick Cotter. Prof. L. D. Metz is faculty advisor for the project.

The machine is being debugged and will be completed shortly. Plans are now being made for student testing of the device.

Salaries Up!

Engineers graduating from the UI in 1965 averaged a 16½ percent increase in salary over those who graduated in 1960 according to a recent survey.

The graduates of 1960 began at $532 a month and rose to $1,416 a month 10 years later. The 1965 graduates started at $633 a month and after five years averaged $1,151.

Graduates of 1960 who have bachelor's degrees average $1,374. Those who earned master's degrees average $1,468; those with doctorates, $1,462. For 1965 grads, without advance degrees, the monthly average is now $1,120; those with master's in the original fields, $1,187; those with doctorates, $1,448.

High Tolerance Thermometer Developed

A new cryogenic thermometer, which measures temperature variances of one two-thousandth of a degree in a range of -459.13 F. to -457.69 F. has been developed here at the University. Prof. Dillon E. Mapother (Dept. of Physics and Materials Research Lab) and Roger P. Ries (Dept. of Electrical Engineering) headed the project.

The thermometer consists of an aluminum wire, a solenoid whose magnetic field affects the aluminum's superconductivity and detection coils to reveal the superconducting condition of the aluminum. It is 6 mm. in diameter and 7.5 cm. long and can be moved without recalibration.

W. J. Poppelbaum:

Challenging Sacred Cows

by Thomas Durkee

"The present-day engineering school graduate is unprepared for what he will find in the working world. . . .Through no fault of his own, the engineer is behind in the battle to save the environment . . . .The close relationship between research and the military is undesirable."

The comments are those of Wolfgang J. Poppelbaum, a Swiss-born professor of electrical engineering and computer science. Wearing no tie and a brown short-sleeved shirt, he is a plump, smiling, middle-aged man who chats freely about the joys and frustrations he feels after 16 years at the University of Illinois. He has a unique point of view that often clashes with popular views or those of his colleagues.

Since coming to the United States in 1954 after earning his Ph.D from the University of Lausanne in Switzerland, Poppelbaum has become a colorful figure on the faculty. As he converses in his office in the Digital Computer Lab, his brown eyes often gaze through the window and far into the distance. Before answering questions, he reflects for a moment, and delivers sound responses about the engineer's role in modern society.

Unique and controversial, Poppelbaum, has a zest for living that is reflected in the way he questions his surroundings.

Poppelbaum says his approach to his work is to challenge common assumptions. As the main inquirer of his computer group, he puts his 30 graduate students to work on practical theses and designing equipment that has interesting applications. Working from the question "Is there a new technology?" they try to examine all the "sacred cows" concerning computers.

By taking this novel approach to research, instead of improving present computer systems, Poppelbaum and his assistants hope for a payoff. The results have been fruitful. In one computer project, the group toyed with probabilistic theory, disregarding the regular analog and digital computer systems. In a given time slot, pulses were made to occur with a probability proportional to the value of the transmitted variable. The result was a stochastic, or random, system of information transfer. The system allows easy multiplication by using AND-circuits and it is being applied to radar operation. In addition, the computer group has devised a project that eliminates noise in video transmissions and improves closed circuit television reception.

On the three days a week that he teaches, Poppelbaum labors from 8 a.m. to 6 p.m., eating lunch on campus. On Tuesdays and Thursdays he usually goes to the laboratory around 10 a.m., returning to his home in southeast Urbana at 6 p.m. He devotes an additional two evenings a week to his profession. On many mornings

W. J. Popplebaum

10 to 15 people stop by his office. Often they are professors or students who encounter problems with research projects. And because of the success of his research group, foreign professors visit Poppelbaum, often relying on him for supper and entertainment.

As chairman of the solid state circuits committee of the Institute of Electrical and Electronic Engineers, Poppelbaum attends committee meetings every few weeks in New York. He wrote the manuscript for a 775-page reference book on computer hardware theory for publication this year by Macmillan. The book has been adopted as a text at several universities including Illinois for use this fall.

Attempting to narrow the gap between college training and industry, Poppelbaum wants to replace humdrum courses with exciting ones. Three years ago he devised a computer hardware course (EE-CS 293), in which he tries to "interest software people (programmers) in the hardware (building) of computers." He points out that few programmers realize that "opening switches and pulling levers can solve hours of work." The course now is required for computer science majors who want to take graduate school qualifying tests. He aso devised EE-CS 385 (Theory of Semiconductor Computing Devices: Logic) and 485 (Theory of Computer Memory Devices).

Commenting on educational reform generally, Poppelbaum says that preparing undergraduates for field work is a financial problem. He finds that it becomes expensive to buy equipment and provide instruction to put students to work on practical engineering problems. While a scientist can talk about something that may happen, he says, the engineering student must learn to fulfill promises in the form of concrete working models. Poppelbaum adds that a bachelor degree should be sufficient for most engineering students, but because of poorly designed curricula it is not. "Shortening the curricula is necessary if people are to do anything before they get too old," he jokes.

Having attended learning institutions in Switzerland, England and Germany, Poppelbaum compares them to American universities. In Europe, he says, much more student time is devoted to reading stacks of books than to attending class. "In American schools information is fed to students by the spoonful," he explains. On the other hand, "European students have no tight homework schedule. They usually go to the first and last classes of the semester, and there are no hour exams. Final exams are devilishly hard, though."

For the man who has not been prepared for the elite universities, says Poppelbaum, the American system is "infinitely superior." He feels that since the percentage of people attending colleges is much higher in America than overseas, the "hard push" approach is necessary for most American students. The main drawback he finds with the American system is that students have little time to do independent work. And it is independence, says Poppelbaum, that marks a useful man.

Sadly missing from America are high level vocational schools, says Poppelbaum. Having technical universities in Europe often gives physics students the choice of the regular university course with abstract applications or the technical university course emphasizing practical applications. The apprentice system still is primary in Europe, he says, and at the average garage a mechanic with four years of training past secondary school will service your car.

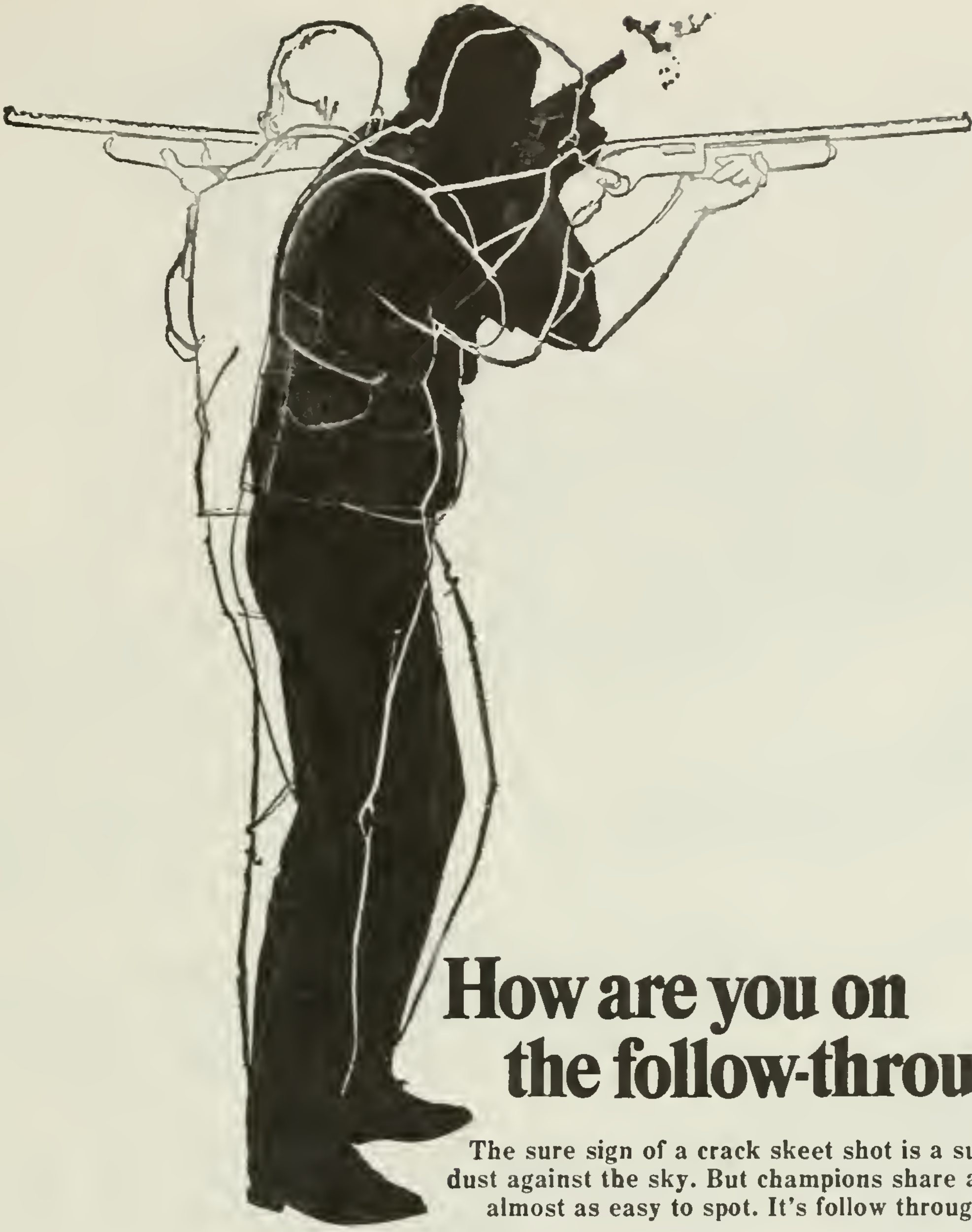
In the university setting, he considers protests of the young a welcome counterbalance to the influence of conservative faculty members. "It's not a bad idea for the more experienced members to run the university," he says, "but we need the friendly and active participation of the young." Poppelbaum praises current attempts in American universities to use the student input effectively. But, strongly preferring evolution to revolution, he criticizes students who exaggerate demands. "Students don't seem to realize that they can modify an existing system widely," he says, "without starting from scratch in every instance."

Poppelbaum considers the annual Advisor booklet to be a positive outcome of "evolutionary" reform at the university. "A teacher must make every effort to convey information," asserts Poppelbaum. "I can see no reason why the victims of university education, the students, shouldn't tell a professor when he's doing a poor job."

To vastly improve higher education, however, Poppelbaum says the assumption of many citizens that professors are incompetent must change. "Some people assume that a person would not pass up additional money if they could make it in industry. This is false," he asserts. Fortunately, he adds, some professors like teaching enough to pass up twice the salary in industry. "I occasionally see a face light up after seeing something for the first time," Poppelbaum relates. "This lighting of little sparks is a satisfying feeling for a teacher." Poppelbaum says he feels at ease with his students and loves to stand in front of classes.

They enjoy his presence, too, according to comments published in the Advisor. A typical student in his computer hardware class commented: "Poppelbaum is one of the few instructors I have who honestly loves to teach. This enthusiasm of his is almost invaluable in imparting understanding and enjoyment."

Another popular assumption Poppelbaum attacks is that the scientist does not feel concerned about society's problems. The scientist, in his opinion, is basically "an adolescent who has been trained to play well with his erector set. When forced with the choice of playing their game," he adds, "scientists (being fallible human beings) may accept money from the only groups willing to invest in their endeavors. I wish it were otherwise, but the



military seems to offer the best financial encouragement."

Poppelbaum says the man to be blamed for misuse of science is the one who earns a profit while causing problems for the environment. "Science can and does tell businessmen how to make a plant smoke-free for an extra million dollars," he points out. Poppelbaum readily admits the practical effects of technology often are negative. But he contends that historical incentive spurs him to continue his work. "We won't be remembered by our descendants for the Great Society or the welfare programs of the 1960's," he says. "A civilization is remembered by its great technological monuments--its pyramids, its aqueducts, its moon walks. I'd like our society to be known by such accomplishments."

Poppelbaum points out that many ecological problems are not engineering problems. As he sees it, enforcing legislation to curb polluters on a large scale is the essential first step. "The engineer has an important role to play in solving environmental problems," says Poppelbaum, "but he has been trained to build bridges. Aeronautical and mechanical engineers would do the less interesting, more useful chores of ecology if they found themselves out of work." He believes the government could take advantage of such situations by retraining unemployed engineers. At the universities he suggests starting a course, such as "Precipatation of Particles in Smokestacks", to interest future engineers in specific problems of society.

Solving problems of society hinges on people with liberal arts backgrounds gaining a better understanding of science, claims Poppelbaum. If people learn to communicate with scientists, he says, they will learn that their tastes affect the uses of science. He finds that imcomprehension of scientific principles frightens many non-science trained college students. "People fear what they cannot understand," he says, "and we have failed to tell the man in the street how the telephone works. Ninety-nine per cent of TV viewers don't know what's inside the box. That must give people an intense feeling of uneasiness." His dream is wide-open university classes that encourage students to learn and discuss science for the sheer fun of it.

Poppelbaum also has advice for engineering students--get a solid liberal arts education. "If the potential engineer is so narrow that his life is all electrical engineering problems, his education is imcomplete," he explains. The arts, he says, offer emotional involvement to complement the rational involvement of science. His praises the five-year engineering-liberal arts program, and boosts programs that divert students from finicky devotion to their special interest.

An enthusiastic hobbyist, Poppelbaum enjoys symphonic music and photography. "I confess to finding some rock music interesting, particularly that of Blood, Sweat and Tears and the rock opera "Tommy," he says. He concentrates on photographing people in lighting that "makes you feel like you're on the cathedral square of Milan." In addition, he belongs to a restoration society for a century-old narrow-gauge railroad in Wales.

A frequent traveler around Europe since he can remember, Poppelbaum did not expect to stay in America when he came here on a Swiss fellowship. But he accepted an assistant professorship at Illinois in 1955, and became an associate professor in 1959, and a full professor in 1963.

Poppelbaum feels too attached to American society to consider moving back across the Atlantic. "Europeans see the intense level of American society as negative," he says, "but I think people learn to adapt to change. And there is a truth to be found in the American attitude of questioning things as people do here every day."

Despite the problems of American engineers, Poppelbaum has faith in the scientific venture and he will renovate education where he can. "I think it's the highest human goal to show the impossible can be done," he says, "and I'm waiting to be convinced otherwise."

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TECHNOGRAPH

October, 1972
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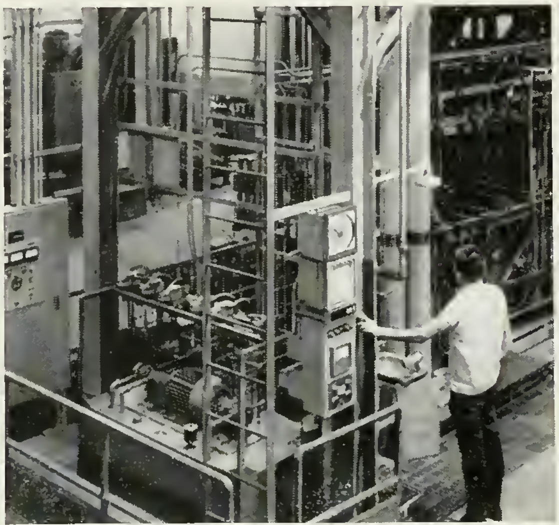
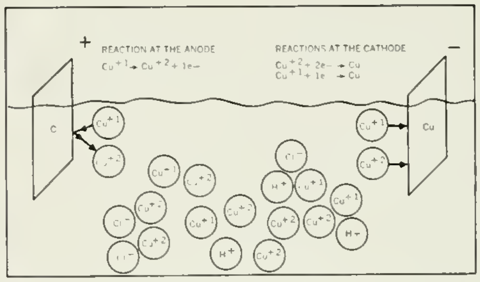
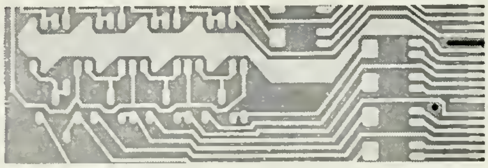
WESTERN ELECTRIC REPORTS



Automatic regeneration and plating machine has a heavy, rubber-lined tank with 22 stationary graphite anodes and 57 rod-like copper cathodes moving at the rate of 90 transfers an hour.



The action at the cathode. Electrochemical reversal of the etching reaction effecting etchant regeneration and copper recovery.



Typical printed wiring board consists of copper (only 0.0028 inch thick) laminated to a phenolic-resin panel. With the new process, unwanted metal is etched away with cupric chloride.

Creating an entirely new way to etch printed circuits.

One of the most common methods of printed circuit manufacturing is by batch-etching with ferric chloride. However, while batch-etching produces circuits of high quality, it also has some processing disadvantages.

For instance, it takes more and more etching time as the etchant is used. Then, to replace the spent etchant means considerable downtime. And the etching of 100,000 circuit boards produces 2000 pounds of copper in a non-recoverable form.

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Their new process is the first closed-loop, spray-etching system that electrolytically reverses the chemical reaction of etching. It continuously recycles cupric chloride and has reduced the cost of etching wiring boards by over 90%.

Virtually all the problems of the old method have been overcome. No more machine downtime is required to change etchant. No more costly ferric chloride is needed. Etchant strength does not diminish. The etching rate is now constant and faster than the average ferric chloride rate. There's no more waste of etched copper. It is now recovered, about 20 pounds per hour, and resold.

Conclusion: The first completely closed-loop cupric chloride etching system in the printed circuit industry is a major innovation that has improved efficiency and quality, eliminated downtime and decreased costs by more than 90%. Furthermore, it has helped conserve a valuable natural resource.

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TECHNOGRAPH

ARTICLES

Engineering Needs Projected

by Keith Erickson*

This article presents a system for employment and educational forecasting which is being developed by the Economics Research Group, at the University's Center for Advanced Computation. Formally known as the System for Training and Education Planning (STEP), it attempts to predict the relative supply and demand for manpower in the United States and at the state level.

The development of reliable forecasts of occupational supply and demand is very difficult on the national scale, and relatively more difficult on the state or local level. Almost all large organizations make some attempt at forecasting or projecting their activities into the future. Even great Universities, such as the University of Illinois, devote a portion of their resources to long range planning. Individuals in positions of responsibility who are faced with decisions strive to be rational and attempt to project future events on the basis of certain observable events remaining constant and others changing.

The STEP system is an econometric input-output model of the U. S. economy. Components of the system encompass areas such as industrial demand, population, migration, occupational mobility, and educational enrollments. When the system is operational various feedback paths will exist to add accuracy to the projections. The STEP system will eventually be operational in the 'interactive mode' on a large computer. This interactive operation would allow researchers and government officials to 'type in' their own opinion of various socio-economic indicators and almost immediately observe the results. This will be accomplished by using remote computer terminals connected to the central computer by standard voice grade telephone lines. The STEP model has been applied to projecting the demand for engineers in Illinois for 1975 and 1980. This projection has been compared to a study of the supply of engineering graduates from Illinois engineering schools. A discussion of the methodology and the results follows.

The method used to forecast occupational demand includes the following components:

i) a set of alternative projected patterns of Gross National Product for future years.

ii) an activity-industry matrix which converts Gross National Product by programs of expenditures into final demands by industry.

iii) an employment inverse matrix which generates total employment generated in each industry by unit expenditure in every other industry.

iv) a set of regression equa-

TABLE 1

ILLINOIS ENGINEERING OCCUPATIONAL EMPLOYMENT FORECAST - 1975

	Budget allocation		
Speciality	**Status Quo**	**Military**	**Welfare**
Aeronautical	411	423	408
Chemical	3280	3346	3318
Civil	13826	13,905	13,871
Electrical	14,487	15,150	14,170
Industrial	13,090	13,695	12,809
Mechanical	17,093	17,836	16,743
Metallurgy	2,089	2191	2,054
Mining	315	317	314
Other	19,003	19,702	18,771
TOTAL	83,594	86,565	82,458

ILLINOIS ENGINEERING OCCUPATIONAL EMPLOYMENT FORECAST - 1980

	Budget Allocation		
Specialty	**Status Quo**	**Military**	**Welfare**
Aeronautical	449	456	449
Chemical	3,689	3,678	3,701
Civil	15,599	15,601	15,632
Electrical	16,351	17,217	15,370
Industrial	15,319	16,066	14,470
Mechanical	19,295	20,184	18,342
Metallurgy	2,341	2,440	2,229
Mining	312	313	311
Other	22,790	23,582	21,994
TOTAL	96,145	99,537	92,498

tions which estimate Illinois employment by industry from U. S. gross exports, U. S. total employment, Illinois total employment, and U. S. total employment by industry.

v) an occupation-industry matrix which distributes the total Illinois industry employment among the various occupations.

The forecasts for Illinois engineering occupations was based on allocations of the national budget. Three assumed budget allocations, or patterns of Gross National Product, were used. Status Quo; which assumes the structure of the economy will remain unchanged from that of 1970. Military; assumes increased defense spending and less spending on domestic affairs such as welfare and education. Welfare; assumes increased spending on welfare and education and less military spending. The results of these forecasts, for 1975 and 1980, are listed on page 12.

The future supply of engineers in Illinois was calculated using the past-rates methods or extrapolating past enrollment rates at Illinois engineering schools. The six engineering degree granting institutions of higher learning in Illinois are Southern Illinois University, University of Illinois at Urbana, University of Illinois at Chicago Circle, Bradley University, Northwestern University, and the Illinois Institute of Technology. Table 3 and table 4 tabulate each institution's contribution to the state total of undergraduate engineering enrollment. Table 5 and table 6 tabulate the individual institution's contribution to the state total of engineering degrees awarded annually for the last ten years. The University of Illinois at Chicago Circle is the institution with the highest rate of growth, and is becoming the state's number two producer of engineering B. S. degrees. It is also interesting to note that the total undergraduate enrollment displayed a decrease for the first time in almost seven years in 1971.

Figure 1 displays a graph of Sophomore engineering enrollment versus time. It is extremely interesting to note that sophomore enrollments peaked in 1968, which was before the job market for engineers became depressed. Sophomore enrollments were considered because they do not reflect the relative uncertainty of freshman enrollments. Sophomores are able to respond to career decisions that involve a change in curriculum because they do not have a high investment in nontransferrable course work, as do juniors and seniors. Figure 2 shows the output of Illinois engineering schools versus time for the last ten years. It seems logical to conclude that the large rate of growth of engineering degree production will not continue.

TABLE 3

TOTAL ENGINEERING UNDERGRADUATE ENROLLMENT IN ILLINOIS ENGINEERING COLLEGES

INSTITUTION	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Bradley	625	614	632	641	631	652	667	763	739	659
Northwestern	844	846	850	784	744	772	784	832	792	781
U of I (Urbana)	3646	3677	3573	3572	3674	3703	3666	3502	3599	3151
U of I (Chicago)	-	-	-	-	-	1545	1890	2051	2139	2122
IIT	819	705	745	779	837	794	765	744	730	698
SIU	-		134	346	341	432	514	468	501	466
TOTAL	5939	5922	5934	6122	6277	7898	8286	8369	8500	7877
% of 1962	100	99.7	99.9	103.1	105.7	133.0	139.5	.140.8	143.1	132.6

TABLE 4

SOPHOMORE ENGINEERING ENROLLMENT IN ILLINOIS ENGINEERING COLLEGES

INSTITUTION	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Bradley	218	115	112	92	117	157	164	173	154	144
Northwestern	283	251	251	211	205	243	221	235	208	217
U of I (Urbana)	773	753	753	843	922	902	942	764	788	759
U of I (Chicago)	-	-	-	-	-	376	416	381	377	405
IIT	236	246	235	302	309	266	261	270	233	243
SIU	-	-	35	90	102	112	108	147	123	127
TOTAL	1420	1365	1386	1538	1655	2056	2112	19.0	1883	1895
% of 1962	100	96.1	97.6	108.3	116.5	144.8	148.7	138.7	132.6	133.5
% of 1967	-	-	-	-	-	100.0	102.7	95.8	89.2	92.2

Figure 1

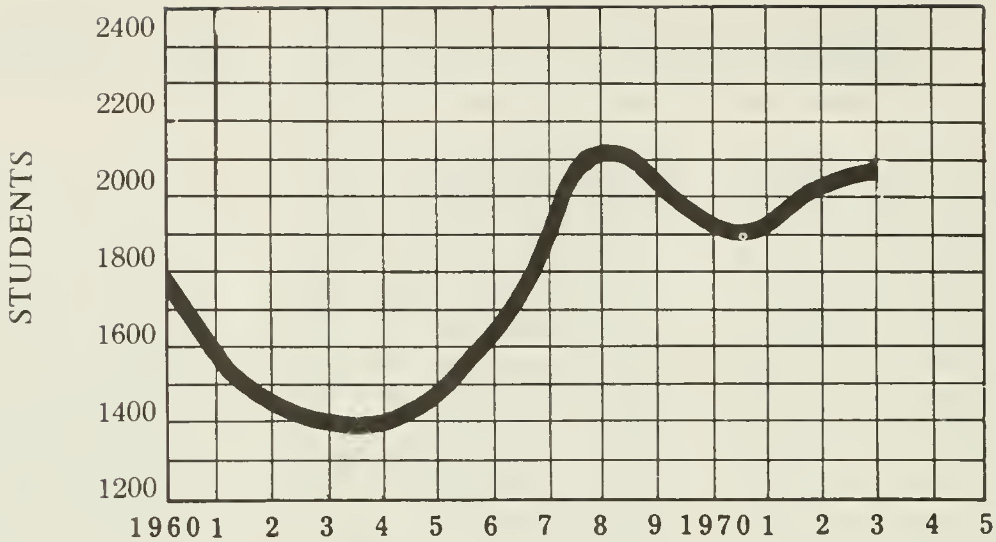


Figure 2

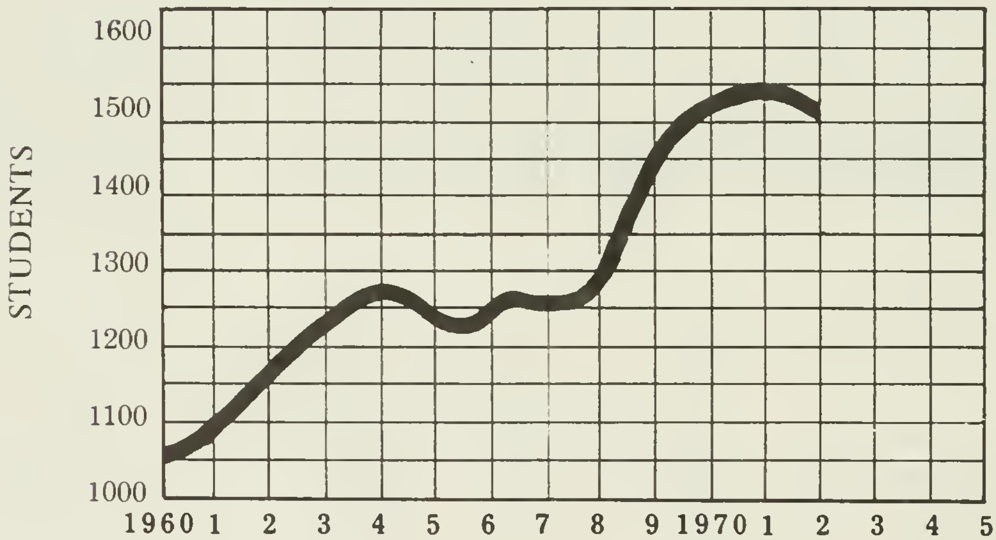
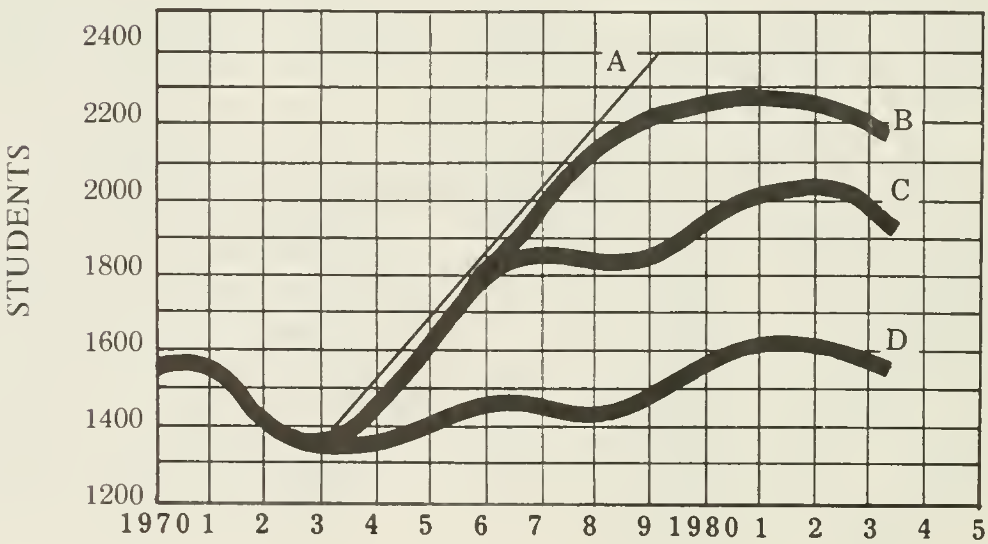


Figure 3



ILLINOIS ENGINEERING BACHELORS DEGREES, 1962-71

TABLE 5

INSTITUTION	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Bradley	60	61	59	65	72	57	66	84	119	113
Northwestern	111	105	112	133	134	127	125	114	130	137
U of I (Urbana)	635	711	743	700	692	694	674	868	683	680
U of I (Chicago)	-	-	-	-	-	-	64	196	294	330
IIT	335	340	360	321	324	337	305	366	290	289
SIU	-	-	-	-	-16	27	24	34	36	27
TOTAL	1141	1217	1274	1219	1238	1242	1258	1480	1552	1576

TABLE 6

DISTRIBUTION OF ILLINOIS ENGINEERING BACHELORS DEGREES BY INSTITUTION, 1962-71

INSTITUTION	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Bradley	5.3	5.0	4.6	5.3	5.8	4.6	5.3	5.7	7.7	7.2
Northwestern	9,7	8.6	8.8	10.9	10.8	10.2	9.9	7.7	8.4	8.7
U of I (Urbana)	55.6	58.5	58.3	57.5	55.9	55.9	53.6	46.4	14.0	43.2
U of I (Chicago)	-	-	-	-	-	-	5.1	13.2	18.9	20.9
IIT	29.4	27.9	28.3	26.3	26.2	27.1	24.2	24.7	18.7	18.3
SIU	-	-	-	-	1.3	2.2	1.9	2.3	2.3	1.7
TOTAL	100	100	100	100	100	100	100	100	100	100

Figure 3 presents some projection of engineering degree production in Illinois for 1985. Four series of projections were used to reflect the four most probable trends. The projections were calculated by assuming a proportion of the total Illinois bachelor degree production. The basic Illinois bachelor degree projections are from **Supportive Study II,** published by the University of Illinois Long Range Planning Committee.

Series A assumes a linearly increasing proportion of all first degrees will be in engineering, growing from 2.73% in 1973 to 7.0% in 1985. This series is excessively high, but the 1985 proportion is substantially below the level of 9.3% which was reached in 1958.

Series B assumes that the proportion of engineering degrees will grow to 3.9% of all first degrees, this is the proportion projected by the University of Illinois Long Range Planning Committee. This will serve as the high alternative.

Series C assumes a rise in the proportion of engineering degrees to 3.4% of the total. This is the medium projection.

Series D assumes that engineering degrees will remain at the level of 2.75% of all degrees to be reached in 1974. This is the low projection.

For the period 1970-74, the forecasts suggest a total number of engineering graduates of 7438, and for the period 1975-1979, number ranging from a low of 7,439 for D, 9,326 for C, 9,928 for B, and 10,537 for A.

When the projections of supply and demand are compared it appears a shortage of engineering manpower will exist. These projections suggest that the market for engineering graduates will begin to improve in 1973, and continual improvement can be expected. The increased demand for engineering graduates coupled with the rapidly declining engineering enrollments will considerably improve the job market for graduating engineers.

It must be remembered that these are only projections and as such can not be believed absolutely.

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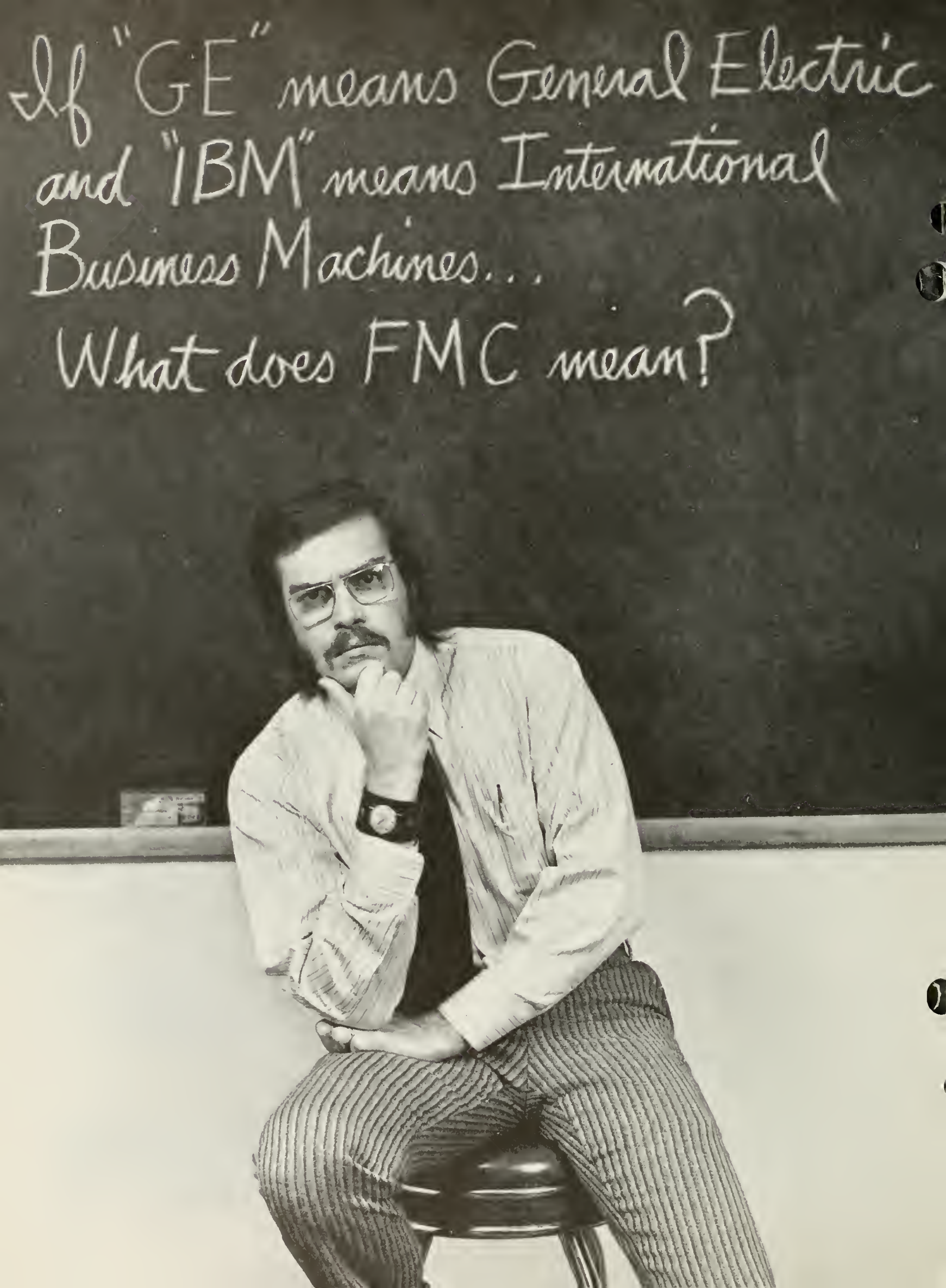
*Keith Erickson is a Graduate Student in the Institute of Labor and Industrial Relations and is employed by the Center for Advanced Computation.


If "GE" means General Electric
and "IBM" means International
Business Machines...
What does FMC mean?

S.T.A.F.F. Project in Offing

Engineers Seek Improved Instruction, Feedback

Have you ever had a problem with an instructor or a course, but gave up on it because it's always been that way? Anyhow, isn't Engineeringland always the last to implement academic reforms? Two former Illinois undergrads see things differently and have put their ideas into action.

David Meller and Robert Watson felt something lacking in the overall structure of the Engineering College, so they went to work and developed the idea of S.T.A.F.F. - Student to Teacher Action-Fast Feedback. They wanted to show the powers that exist "that there is a viable way to improve instruction that is better and more positive than the **Advisor**," according to Meller. S.T.A.F.F. would attempt to solve one of the basic problems identified by Meller and Watson: that instructors have very little idea how effective their instruction is.

The ideas for S.T.A.F.F. were formalized and presented to Dean Wakeland last March, and the organization went into operation after Easter vacation on an experimental basis. Students were urged to call in their problems, upon which the S.T.A.F.F. volunteers would immediately go to work and try to find a solution. The emphasis was on what Meller calls "Information Channelling", not on accusing or assigning blame. Meller feels that "if blame is to be put, it's on the Administration."

The mechanics of S.T.A.F.F. are simple. A student calls about a particular problem with a class or instructor. The student can remain anonymous if he wishes. If the S.T.A.F.F. volunteers can't handle the problem, it is referred to a faculty committee which tries to find a solution to the problem. No names are mentioned when a problem is given to the faculty committee to consider.

A file of problems and solutions is kept by S.T.A.F.F. and can be referred to by the volunteers when similar problems come up. It is also suggested that T.A.'s, who might have limited experience in the classroom, use this file to help with their teaching problems.

Ideally, the S.T.A.F.F. volunteers will be juniors or seniors in Engineering who are familiar with the college and its problems. The faculty committee consulted last spring included: T. A. Murrell, C. S.; M. L. Babcock and P. E. Mast, E. E.; L. D. Metz, G. E.; H. Krier, A. A. E.; R. W. Bohl, M.M.E.; J.W. Bayne, M.E.; and H. R. Smock, O.I.R. Hopfully the other departments will nominate faculty members to this committee also.

In the trial period last spring, S.T.A.F.F. was not overwhelmed with calls. Meller attributes this to lack of student knowledge about the project due to insufficient advertising. However, 27 calls were received about 21 different problems. According to the report by Meller and Watson," Of the seven items on which we received sufficient information to judge, five of them resulted in changed instructional methods. Of the same seven items, two resulted in no change. These latter two items were the only times that we received multiple calls on the same problem."

Meller plans to present his report to the Engineering Council with the suggestion that they implement the program this fall. Students interested in the development of S.T.A.F.F. can reach Meller in his office at 361 Engineering Research Lab, or 333-6500 ext. 41. As Meller sees it, "Progress toward providing effective instruction is inevitable, when the time comes that we are willing to forego assignment of personal blame and are willing to devote the same energy to supporting a viable guidance system."

Nobel Prize Winner

Prof. Bardeen - Research Top Priority

by Pat Polleti

Imagine a train running one foot above the ground along a track composed of a sheet of metal at speeds of 300 mph or greater. Fantasy, you say. Fact. Japan is currently workng on such a project and expects to have a line of levitating trains in operation by the 1980's.

This is only one application of the principle of superconductivity discovered by John Bardeen, professor of physics and electrical engineering here at the University.

Bardeen was born in Madison, Wisconsin, on May 23, 1908. He received his BS and MS degrees in electrical engineering from the University of Wisconsin in 1928 and 1929. For the next three years he worked as a geophysicist at the Gulf Research Laboratories in Pittsburgh, concerned with the development of methods for the interpretation of magnetic and gravitational surveys.

Bardeen left Gulf in 1933 to take graduate work at Princeton University. It was there under the direction of Prof. Eugene Wigner that he first became interested in solid state physics and was awarded the Phd degree in 1936 for research on the theory of the work function of metals.

When he came to Illinois in 1951, he put his all-encompassing interest to full-time study. Seven years later, he and two graduate students, J. R. Schrieffer and Leon Cooper, developed the microscropic theory of superconductvity.

In essence, the theory states that certain metals and alloys lost their resistance to the flow of electric current at temperatures near absolute zero. This change in the property of metallic elements has puzzled scientists for decades.

Under normal circumstances, the flow of electric current is blocked by bound electrons within the metal. However, immersion in liquid helium, the only gas that does not solidify when exposed to such extreme cold, alters the metal's nuclear structure so that the bound electrons are released. Without resistance, the current flows, continuously, thus creating a state of perpetual motion.

Bardeen's explanation of this phenomenon has been heralded as one of the greatest achievements in physics of the century, even greater perhaps than his work with transistors for which he together with W. H. Brattain and W. Shockley was awarded the Nobel Prize in 1956. Bardeen feels that these studies are of more scientific interest, although they will never have the same economic benefit as the transistor.

Bardeen is currently engaged in research with several graduate students probing various aspects of the theory. "There has been a great deal of development since 1957", he says, "applying it to many different situations, experimenting with possible ways of making superconductors and what sort of combinations of metals and alloys may be used and exploring their limitations." The major problem now, he contends, is trying to find superconductors that will operate at higher temperatures. he present maximum figure is 21 degrees above absolute zero.

The technological potential of superconductivity knows no limits. According to Bardeen, the applications have been in other areas rather than in the general consumer market.

Superconductors, he says, smaller than the smallest transistor, are being used as computer components, both for logic and memory systems. "Superconducting magnets are now commonplace in laboratories throughout the world." In the area of health care, he notes, they are being used to measure signals from the heart--in short, a more compact, efficient electrocradiagram.

One of the most significant applications of the B-C-S theory, he claims, is reflected in the experimentation now going on with nuclear fusion. The University of Wisconsin is currently working on a project to the order of $20-25 million nationwide. The basic problem under consideration is whether an atmosphere of extreme low temperature can be produced large enough to contain an equal temperature of extreme heat. If fusion energy ever becomes a reality, he asserts, it may provide an answer to the present fuel supply crisis.

During his career, Bardeen has acquired a long list of awards in addition to the Nobel Prize--the National Medal of Science, the Medal of Honor from the Institute of Electrical and Electronics Engineers, the Fritz London Award, the Vincent Bendix Award and the Buckley Prize to name a few--as well as honorary degrees from institutions such as Princeton, the University of Glasgow, Notre Dame and Rose Polytechnic.

Despite his reputation as a brilliant physicist, Bardeen shuns the limelight. Thickset, clothed in a very businesslike suit and tie accentuated by thinning hair and slightly grayish temples, he looks formidable. Yet, the strong, steady handshake and penetrating eyes screened behind black frames conceal a shy, retiring man with a soft almost unaudible speech, who prefers research in a quiet University climate over a career in industry.

Research: this is Bardeen's strength, this is his whole life. The majority of his time is spent in his corner office of third floor Physics Building, laboring over a desk crowded with technical briefs. Occasionally, his work is interrupted by a conference with one of his thesis candidates or a lecture to a group of bewildered graduate students.

Although teaching occupies only a minor part of his weekly routine, he has some very definite feelings about education, specifically education at Illinois. Alarmed by the current budget reductions, he says, "You can't cut back continually and expect to have a first class institution." He is equally critical of the rising tuition costs, which he holds responsible for the declining enrollment north of Green Street. He would rather see the money come from the state than from students' pockets.

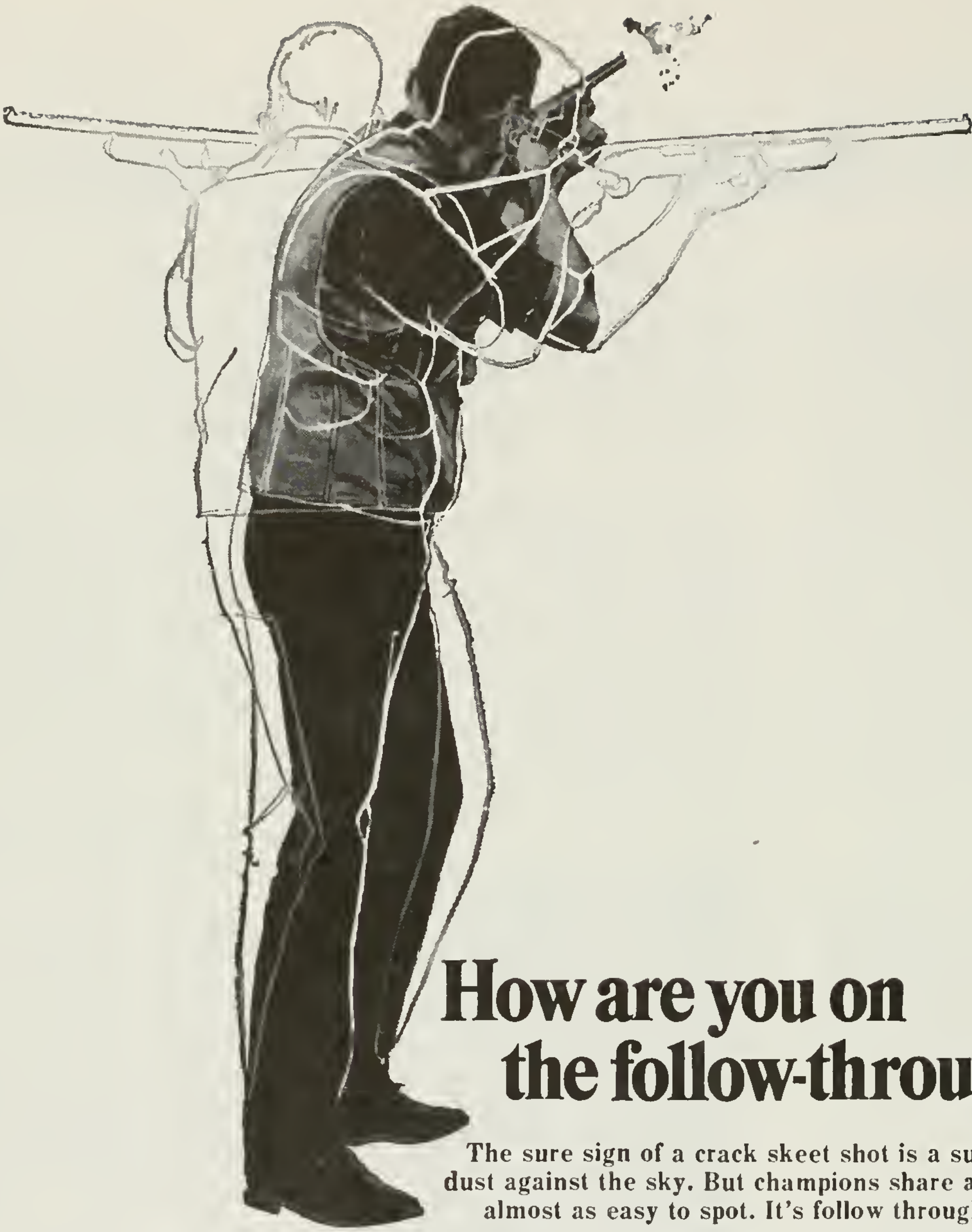
Unlike many educators who think that today's students are spoonfed, Bardeen feels they are "interested and capable" and "most of them work pretty hard". He strongly approves of the proposed curriculum changes, calling them "all good moves". He is particularly in favor of the new liberalized degree requirements. Decreasing the total number of hours toward graduation and at the same time increasing the number of electives, he predicts, will give the student greater freedom to pursue his own interests and better prepare him for a career in his chosen field.

Mention of the "Military Industrial Complex" in reference to research funding north of Green Street evokes emphatic comment from the normally reticent man. Although much of the money, he admits, comes from the federal government, in nearly all cases, he says, the professors initiated the projects. He recalls his six years, 1945-51, at the Bell Telephone Laboratories where the pressures were intolerable. The government, he insists, doesn't impose any more limitations than industry. His own war with superconductivity was financed by the Army.

Bardeen sees similar fallacies surrounding the issue of on-campus recruiting by companies engaged in "immoral activities". "The companies that come here are no different than any other companies." Polls taken within the departments, he says, indicate an intense awareness and concern over the tight job market today. "Students overwhelmingly want recruitors; they want to get jobs."

Popular debate over the question, he explains, is merely an expression of the Anti-Vietnam protest and to a larger extent, of the lack of public understanding about the relations between science and government. From 1959 to 1962, he served on the President's Science Advisory Committee, working to bridge this communications gap. As a member, he was concerned mainly with military and space problems and was instrumental in getting NASA started.

From his work on the committee, Bardeen has formed views on what role science performs in this country. He would like to see scientific discoveries used for peaceful purposes, "helping out the general population." But like many scientific discoveries that have in the past been believed impossible, this hope, too, may take years to find complete fulfillment.



A View of Engineering at Illinois

WHEELCHAIR TREADMILL

A special treadmill for wheelchairs has been developed at the University of Illinois. It is a device for engineering and physiological research on locomotion for the handicapped.

Attached to the wheelchair are instruments which measure expenditure by the rider, his respiration, heart action, circulation and other factors. The wheels of the chair are supported on rollers whose resistance and inertia can be controlled. Measurements and motion pictures can be made simultaneously as all actions of locomotion occur without leaving one spot.

The treadmill was developed as part of a doctoral thesis in mechanical engineering by Roger L. Brauer, Tolono.

Brauer's research used 16 wheelchair students from the division and 20 able bodied students. It established data on effort and other factors involved in wheelchair use, and opened the way for further research on the effect of wheeling on individuals which may ultimately lead to improvements or redesign of the wheelchair or its components.

It indicated more study is needed on fitting persons to wheelchairs so that armrests and back support frames do not interfere with wheeling.

And it showed that experience, conditioning and proper wheeling techniques are important—and that persons regularly in wheelchairs do better with less effort than able bodied persons.

PENNIES FROM HEAVEN

The university received a $2,110,000 grant from the National Science Foundation in August. It continues support for the Materials Research Laboratory at the yearly rate previously scheduled by the Advanced Research Projects Agency of the Department of Defense. The lab performs basic research in materials science and provides advanced training to materials scientists and engineers.

Prof. Robert J. Maurer, director, is a professor of physics. All faculty associated with the laboratory similarly hold academic appointments in the engineering and physics departments.

The lab building and equipment provide the specialized, expensive instrumentation such as scanning electron microscope facilities and a three million volt accelerator for electrons and protons, needed for the research.

A project by Prof. Willis Flygare, a chemist, has used laser light which is scattered by large molecules in solution to identify protein molecules of biological importance.

The Materials Research Laboratory is one of the University of Illinois' unmatched facilities for teaching and research in the sciences and engineering. Its important role is to bring research workers from different disciplines together in an interdisciplinary organization to avoid narrow overspecialization and to stimulate the broadest possible attack on materials problems.

DIRTY LAUNDRY?

"Great balls of fire!" exclaimed the busty co-ed as she withdrew her shredded unmentionables from the washing machine. What is the cause of this blight which has been spreading to laundromats throughout the university? A horny Mr. Clean in the washer? No, the cause is abrasion and corrosion from chemicals in some detergents.

These attack the enamel surface of the washer. Prof. Clifton G. Bergeron of the University of Illinois department of ceramic engineering, in research sponsored by the Ingram-Richardson Co., Frankfort, Ind., is putting the problem under the microscope. Enlargements of the affected surfaces revealed that weaker or softer parts of the enamel are eaten away and then stronger areas are attacked from many directions.

The information will lead to more resistant coating, through different formulas or possibly changes in application.

notes & news

Help Wanted—Steelmaking

We're planning to talk with a lot of candidates for employment in Steel Plant Operations during the next few months. Students working toward M.E., Met. E., E.E., or several other engineering or technical degrees should give serious thought to careers in steelmaking through the Bethlehem Steel Loop Course. And remember, we're a leader in steelmaking technology—our capital investments total $980 million for the last three years alone!

A word to the wise—COAL

According to the U.S. Bureau of Mines, our nation's consumption of bituminous coal will *double* by the year 2000. That fact alone suggests something about career opportunities in the coal operations of our Mining Department. We're looking for mining, electrical, and mechanical engineers.

Steel's magnetic "personality"

Iron and steel are magnetic. So, what's the big deal? Just this: ferrous wastes are the easiest materials to recycle. Magnetic extraction separates ferrous scrap from trash, recovers metal after waste incineration, even permits "mining" of dumps. About 50% of all new steel is made from iron and steel scrap.

Construction Quiz:

What do San Francisco's Golden Gate Bridge, New York City's Madison Square Garden Center, Washington's Robert F. Kennedy Memorial Stadium, and Chicago's CNA Building have in common? Answer: fabricated and erected by Bethlehem's Fabricated Steel Construction Division. That's where the action is for people who want to help build the big ones!

From inspiration to application

Three Bethlehem researchers recently won the AIME's coveted Charles H. Herty, Jr., Award for their paper describing a significant steelmaking advance from conception to application. The team developed a high-speed automated sensor lance that measures both bath carbon and bath temperature instantaneously during the BOF steelmaking process.

Want more information?

We urge you to read our booklet, "Bethlehem Steel's Loop Course." If copies aren't available in your placement office, drop us a line. Write: Director—College Relations, Bethlehem Steel Corporation, Bethlehem, PA 18016.

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Well, you call one a Sylvania compact stereo system. It's stacked and compact with tuner/amplifier, turntable, and tape player all in one unit.

And you call the other a Sylvania component stereo system. Each unit is separate so you can spread it around any way you want it.

Inside, though, they're the same. Both have an RMS rating of 12.5 watts per channel (20 watts IHF) with each channel driven into 8 ohms. There are identical FETs, ICs, and ceramic IF filters in the AM Stereo FM tuner/amplifiers. Both offer the same switchable main and remote speaker jacks, headphone jacks, aux jacks, tape monitor, and built-in matrix four-channel capability for the new quadrasonic sound. The turntables are Garrard automatics with magnetic cartridges and diamond styluses. The 4-track stereo record/playback cassette decks are the same. And both air-suspension speaker systems contain two 8-inch woofers and two 3-inch tweeters.

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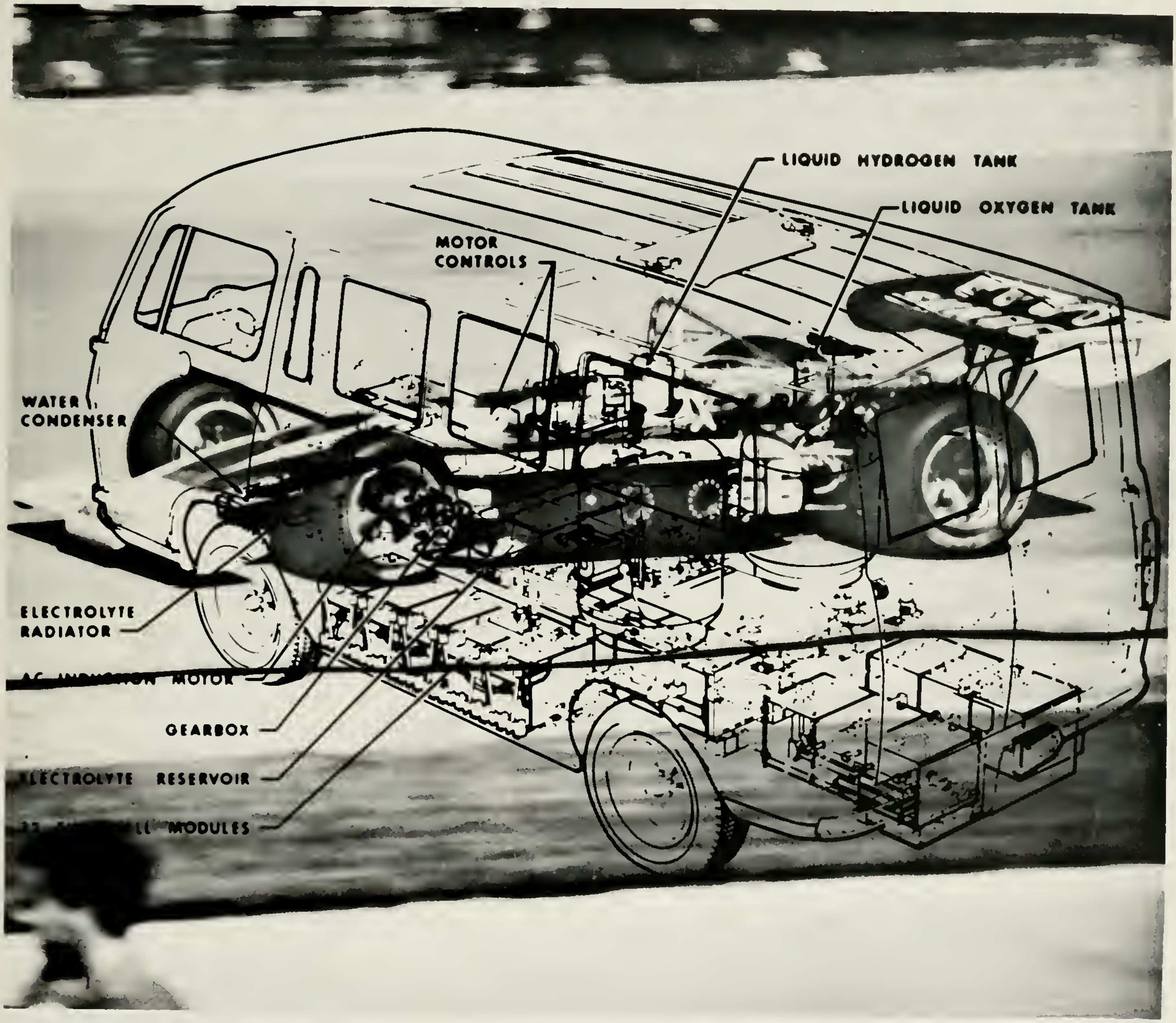
...the magazine for Engineers



Hydrogen at the INDY?

UNIVERSITY OF ILLINOIS
OCTOBER 1973
VOL. 89 NO. 1
MEMBER ECMA

Technograph

Starting next issue. . . .

LETTERS TO THE EDITOR

Send Your Comments Gripes Suggestions to 302 Engineering Hall

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Hydrogen:

...the fuel of the future?

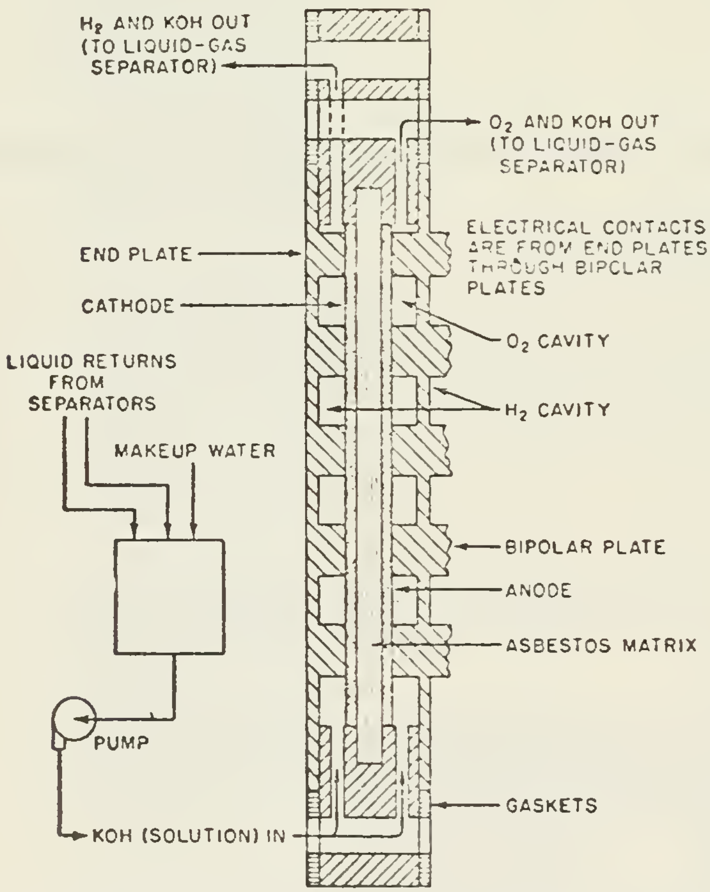
by Mary Jo Koncel
and Marianne Andrasek

Imagine cooking your meals, heating your home and running your car by the burning of hydrogen gas. Sound far-fetched? An increasing number of scientists are contending that hydrogen could be the fuel of the future.

Although hydrogen may seem like a strange type of fuel, it has many desirable characteristics, the most important being that it burns without polluting. Hydrogen is derived from water by electrolysis and when it burns, it reunites with oxygen to make water vapor. It is non-polluting and it recycles to its original state.

Another advantage of hydrogen is that unlike electricity, it can be stored in caverns or large cryogenic tanks to be available on demand. Storing hydrogen for peak-power-use provides a means of obtaining more efficiency from a power plant system.

The cost of transporting hydrogen can be competitive to systems now in use. According to Dr. Derek Gregory, assistant director of engineering research for the Institute of Gas Technology in Chicago, the estimated cost of transporting hydrogen over a 100-mile-length by pipeline is \$.22/million BTU, while that of high voltage overhead transmission of electricity for the same distance is \$.62/million BTU. Hydrogen can be moved in pipelines similar to ones used for natural gas, though the transportation of hydrogen requires more pressure pumps since it is three times less dense than natural gas.



Schematic design of end cell in Allis-Chalmers bipolar water-electrolysis cell.

Scientists agree that hydrogen may be susstituted for most existing forms of energy. It could be adapted to the market as an intermediate product, being derived from some source of energy, like nuclear power, then being distributed to the point of use. According to Dr. Winsche of Brookhaven National Laboratory in New York, hydrogen can be substituted for petroleum and coal in almost all industrial processes which require a reducing agent, examples being steel manufacturing and other metalurgical operations. He says hydrogen can be easily converted to a variety of fuel forms such as methanol, ammonia and hydrazine.

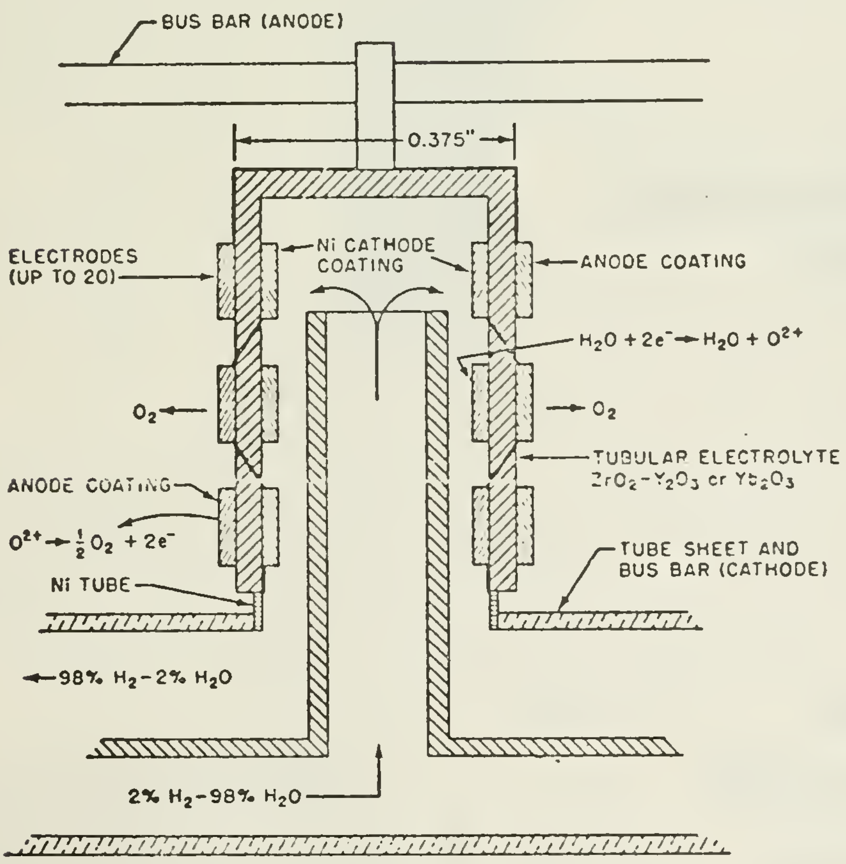
Using hydrogen as a major fuel presents a problem, though, because the present methods of producing it are uneconomical for producing large quantities. Several methods of producing hydrogen have been researched and the following is a survey and comparison of these methods.

The conventional methods of producing hydrogen will be mentioned as a basis for comparison. Today the most widely used methods of producing hydrogen are partial oxidation of hydrocarbons, catalytic steam reforming of natural gas, and processes using coal and coke. In all three processes, a carbon monoxide and hydrogen mixture is obtained and then is converted to carbon dioxide and hydrogen.

According to Dr. Gregory, the present costs of producing hydrogen from these fossil-fuel based processes range from $.92 - 2.15/million BTU. If this price range is compared to that of natural gas in the Chicago area, $.90/million BTU, it is obvious that hydrogen cannot compete economically as a major form of energy in today's market.

In the electrolysis process of producing hydrogen and oxygen from water, nuclear heat is used to power the electrolysis plant. Two advanced electrolysis cell designs have been researched by the Allis-Chalmers Company and General Electric.

The water-electrolysis cell designed by Allis-Chalmers consists of two porous electrodes separated by a thin asbestos membrane, which holds the electrolyte, aqueous potasium hydroide, in contact with the electrodes. Porous electrodes can support much higher current densities than smooth-plate electrodes due to the large specific surface area of a porous substance. This arrangement permits operation at much higher current densities as it eliminates internal resistance losses due to voids in the conduction path between electrodes. Design operating conditions are gas generation at 300 PSIG at a temperature of 250 degrees Fahrenheit and a current density of 800 amps per square feet.



Schematic design of single tube in proposed General Electric steam–hydrogen electrolysis cell.

The design by General Electric is a high temperature vapor-phase electrolysis cell. This system uses solid zirconia which contains other oxides such as calcia, yttria and ytterbia. Conduction is almost entirely by transport of oxygen anions and it increase exponentially with temperature.

The cell operates at 2000 degrees Fahrenheit and consists of an inner electrode of nickel and an outer electrode which may be praseodymium cobaltate, a complex oxide compound.

The Allis-Chalmers cell design is in an advanced stage of development while the General Electric cell is only in a conceptial stage. See figures 1 and 2.

Hydrogen produced by present-day electrolysis technology costs about $3.50/million BTU. The estimated cost of the advanced processes proposed by Allis-Chalmers and General Electric range from $.78 1.03/million BTU, respectively. This price includes the cost of electricity needed to run the electrolysis plant, which accounts for 60-70 per cent of the total operating cost. The credit from the sale of oxygen, $4/ton, is included in the estimated cost.

Either a fuel cell or conventional steam turbine can be used to convert the hydrogen produced by electrolysis to electricity.

NASA has been using fuel cells and developing new technology, much of which has been adapted and used by industry. Privately, utility companies have built small demonstration models and are now attempting to produce large-scale fuel cells for the future.

A thermochemical process can also be used to produce hydrogen. Hydrogen can be chemically produced using nuclear power for the heat needed in the chemical reactions. A direct one-step method such as the decomposition of water requires very high temperatures on the order of 4,500-5,400 degrees Fahrenheit. Problems of machine limitations and large BTU input make this an uneconomical approach to hydrogen production.

Another approach using a multi-step process at temperatures less than 1,400 degrees Farenheit has been proposed. Two methods are being researched now.

The first method, the Mark I process, is being developed in Italy by Gianfranco De Beni an Cesare Marchetti. As of yet, only the reaction equations are available:

Essential Reactions in Mark I Process: .

1) $CaBr^2 + 2H^2O \xrightarrow{1,350°F} Ca(OH)^2 + 2HBr$

2) $2HBr + Hg \xrightarrow{480°F} HgB^2 + H^2$

3) $HgBr^2 + Ca\ (OH)^2 \xrightarrow{212°F} CaBr^2 + H^2O + HgO$

4) $HgO \xrightarrow{\quad} Hg + \frac{1}{2}O^2$

The other low temperature process was proposed by Bernard Abraham and Felix Schreiner. It consists of a three step chemical cycle not exceeding 920 degrees Farenheit, and avoids the problem of separating a hydrogen and oxygen mixture.

1) $LiNO^2 + I^2 + H^2O \xrightarrow{\quad} LiNO^3 + 2HI$ 80°F

2) $2HI \xrightarrow{\quad} I^2 + H^2$ 800° F

3) $LiNO^3 \xrightarrow{\quad} LiNO^2 + \frac{1}{2}O^2$ 920° F

Both the Mark I and lithium based processes are still in the experimental stage. The overall efficiency of the Mark 1 cycle is 55 per cent, but Marchetti claims that an efficiency of 85 per cent is possible without giving any information as to how this figure was determined. All the chemicals needed are readily available with the exception of CaBr, which is rather expensive. The second process involving lithium gives the greatest ratio of weight of initial products to hydrogen produced, with large quantities of lithium available on the market.

Both processes are feasible in the laboratory and it is possible to recover the catalysts, but the question remains whether it will be possible to produce these reactions economically on a large-scale.

Two extensive surveys of hydrogen production methods have been carried out, one at TEMPO with supportive data by Southern California Edison Company and the Oak Ridge/AEC, and the other by Dr. Winsche. The results of these surveys are in figures 4, 5, and 6.

Will hydrogen be the fuel of the future? The feeling of both surveys is that with the necessary technology, hydrogen energy is economically possible in the future.

FIGURE 3
EFFICIENCY

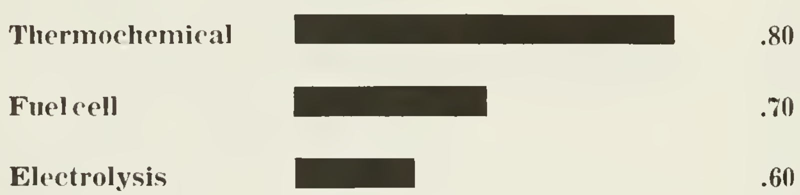
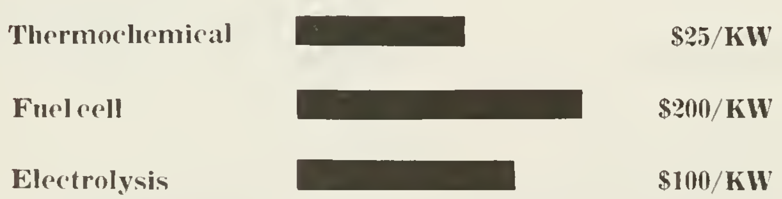
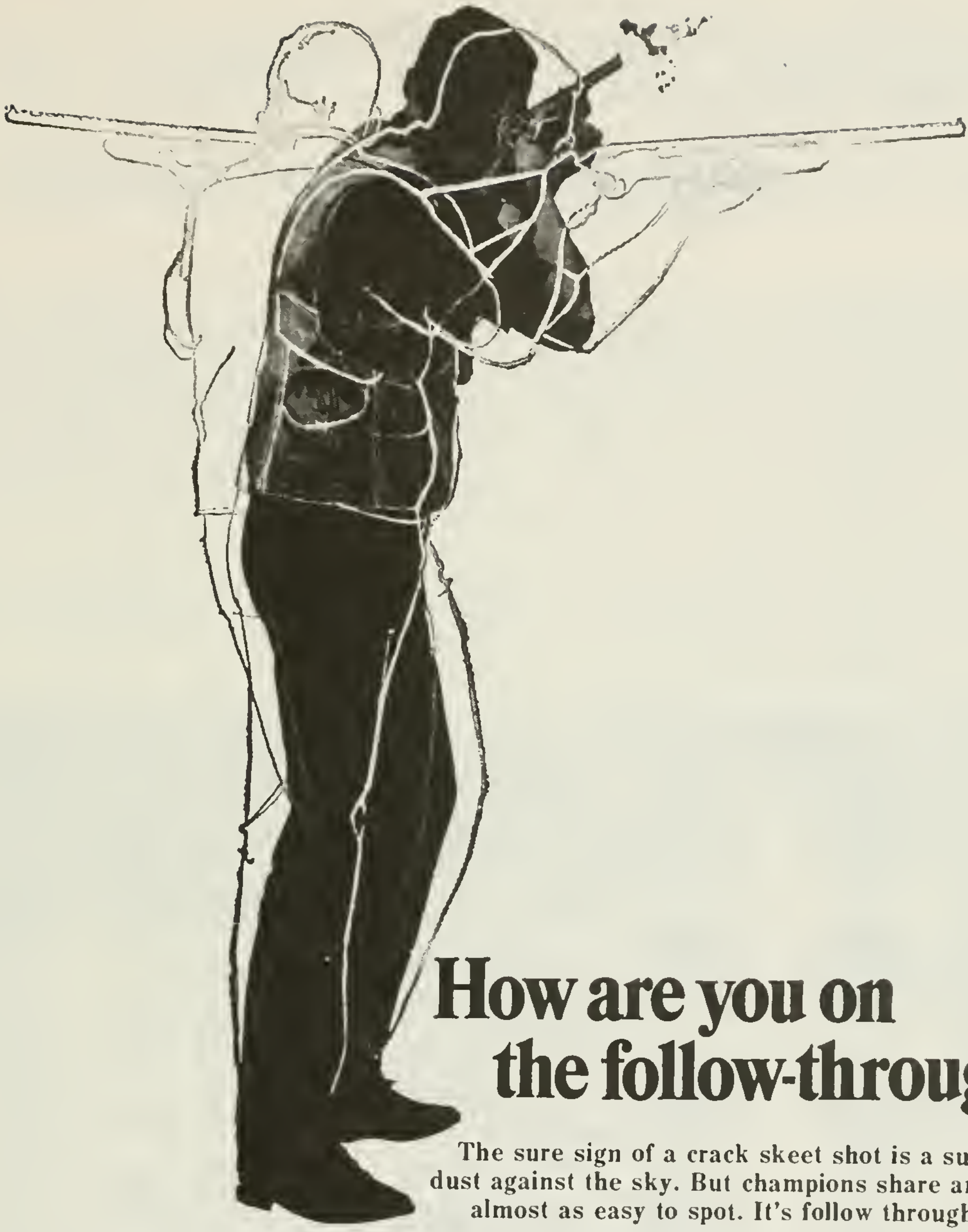


FIGURE 4
COST





A VIEW OF ENGINEERING AT ILLINOIS

JOBS

What about last years' graduated seniors? Are they sitting on park benches or are they dutifully employed? Our new placement director, Mr. Opperman, presented a survey of June 1973 graduates which was very comprehensive according to salaries, companies and location. At the time of the survey, only 38 out of 454 engineering graduates were still available for work.

The average salary was $933 with a high of $1100. About half of the graduates were employed by firms in Illinois with California and Texas as runners-up. As an alternative to employment, many graduates had "miscellaneous" occupations. Some of these were traveling, recording music and writing books.

Summer jobs for undergraduates will be increasing in the future, according to Mr. Opperman. He noted that many more companies looked for student workers for this past summer and he feels that this tendency will continue to increase in following summers. A summer job bulletin is published on a weekly basis in the spring and students are encouraged to refer to this as they look for a job.

The co-op program is growing rapidly, according to Mr. Opperman. Students interested in this type of work-study program are invited to see Mr. Opperman in the placement office in Engineering Hall.

NORTH OF GREEN

Have any noteable news? If you want it published in North of Green, see Peggy Whelan in 112 Engineering Hall.

SELL YOURSELF

Job hunting is a problem that every engineer will confront sometime in the future. E. Aldrich and T.A. Triebes of Dow Chemical have written some guidelines for the engineering job hunter.

One of the most frequent mistakes of the engineer is that he finds himself interviewing a company about which he has little knowledge and is discussing a position totally unsuited to his interests and abilities. This is due to the lack of personal salesmanship when the engineer goes to look for a future employer.

If the company understands the interests and capabilities of the engineer, it can establish meaningful problems for its new technical employee. When the engineer assists the company through an aggressive and alert approach, the chances of his getting a meaningful and rewarding job are increased. The engineer should try to sell himself into a position; he should not sit around to be placed.

Effective communications with the company is essential for the engineer. He must distinctly present his strengths, weaknesses, experiences, and attributes to his future employer. The engineer must also tell of job desires and challenges that he is looking foward to. The impressions the engineer communicates in an interview are a result of his own salesmanship-and he **must** sell himself.

To prepare himself, the engineer should do a fair amount of research about the company prior to the interview. It is the time for him to decide whether or not he is definitely interested in working for that company. Brochures on the firm stating the firm's philosophy, objectives, opportunities and scope are a great help to the engineer. Impressions of a company should be sought from college professors, fellow job seekers, summer employees and friends who are or were employed by the company.

Looking for growth in a firm should also concern the engineer. In a public corporation, the earnings, cash flow, and stock price over the last few years will help determine potential growth. Trade magazines, advertisements and news items also help.

A concise resume is required of the applicant. The resume should summarize the engineer's objectives, job interests and strong points. School libraries and placement offices can be of help in writing this resume.

When interview time comes around the engineer must be prepared to ask questions which

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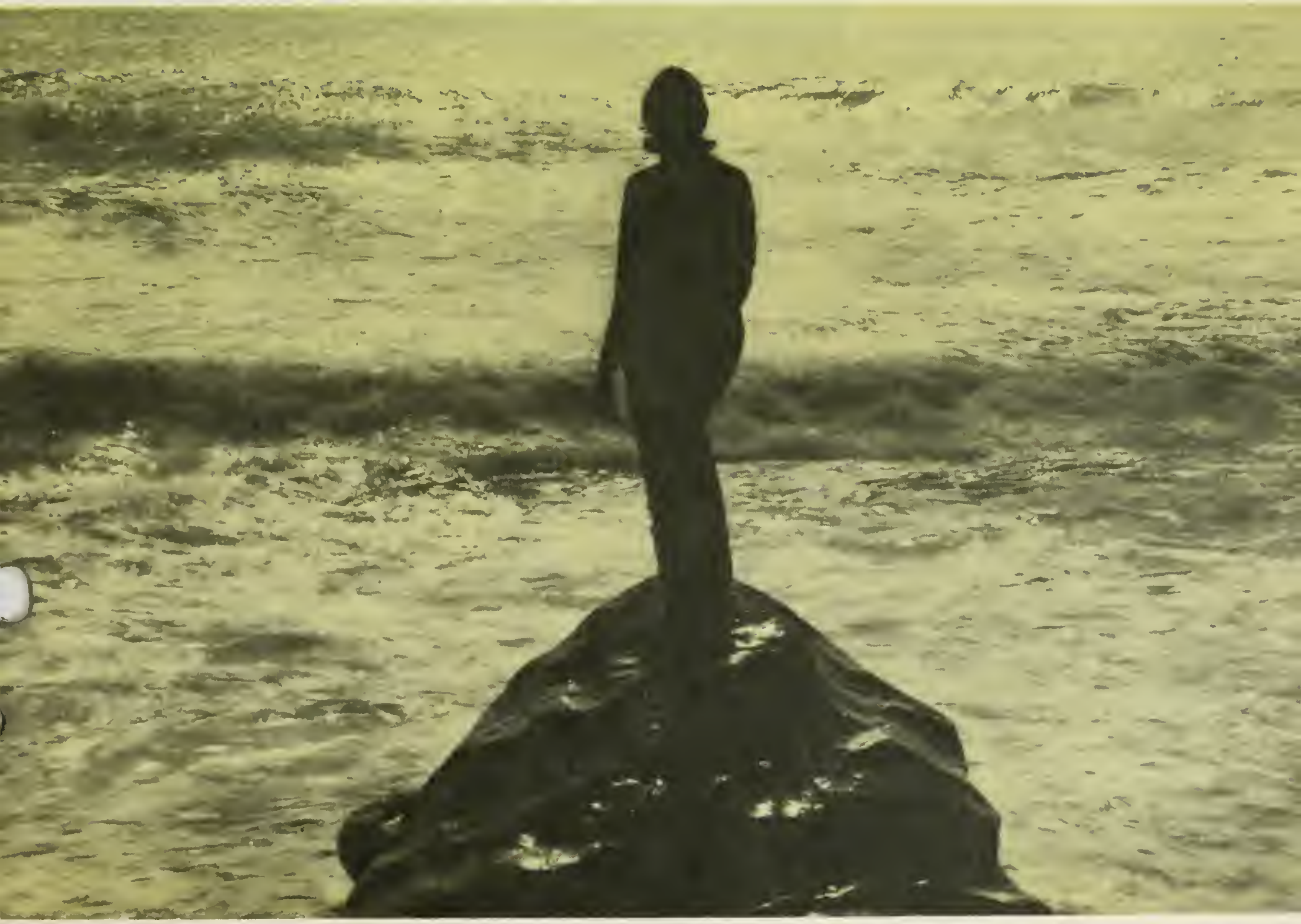


Wanted / solution to the gasoline shortage

Cover-Taking the turn at 220 MPH is a Sunoco-DX-McLaren car driven by Mark Donahou in the 1973 Indy 500. Over that is a hydrogen powered car, which may sound far-fetched at the Indy but may become a reality on the road.

(Pictures courtesy of Dr. Richard Alkire and Dr. Dan Metz)

LIQUID H^2-AIR HYBRID powered car

by Tom Andrasek

Recent newspaper headlines informed a startled public that the nation was in the midst of something previously thought impossible. Those headlines told of a nationwide gasoline shortage that could prove crippling.

What are the implications? Spot shortages, voluntary rationing, and soaring prices foreshadow possible future crises. The shortage could seriously affect practically every mode of modern transportation. Fuel supplies are already being rationed to a degree. In some way, the average American will feel the pressure.

Different solutions have been proposed and are being intensively studied. Along with governmental agencies, various universities, including the University of Illinois at Urbana, are working on this problem.

William E. Simon, deputy Secretary of the Treasury and chairman of the government's oil policy committee, has said that the Nixon administration is ready to implement a plan for allocating gasoline supplies among refiners and distributors. The purpose of the plan is to "share the shortage;" though the gasoline supplies are limited, everybody would be short by the same amount.

Another approach has reached the American public via television. Various speakers, among them singer Johnny Cash, have advocated lowering speeds to conserve gasoline. For example, a car traveling at 50 miles per hour uses nearly 24 per cent less fuel than a car going 70 miles per hour.

For a third approach, engineers could examine the engines of today's vehicles to see if their design is helping to cause the fuel shortage. Probably a new type of engine could be developed which would consume the least amount of fuel possible, yet would meet pollution control standards. Perhaps these new engines could run on electricity instead of chemical energy. Possibly a small steam turbine would be marketed as a better vehicle powerplant.

The hidden flaw of this type of solution is that our nation cannot continue to solve its technological problems by constructing something new. Millions of vehicles in this country today operate by reciprocating engines and these powerplants cannot simply be abandoned. Modern analysis is a must.

This type of analysis is being performed by staff members of the Mechanical Engnieering

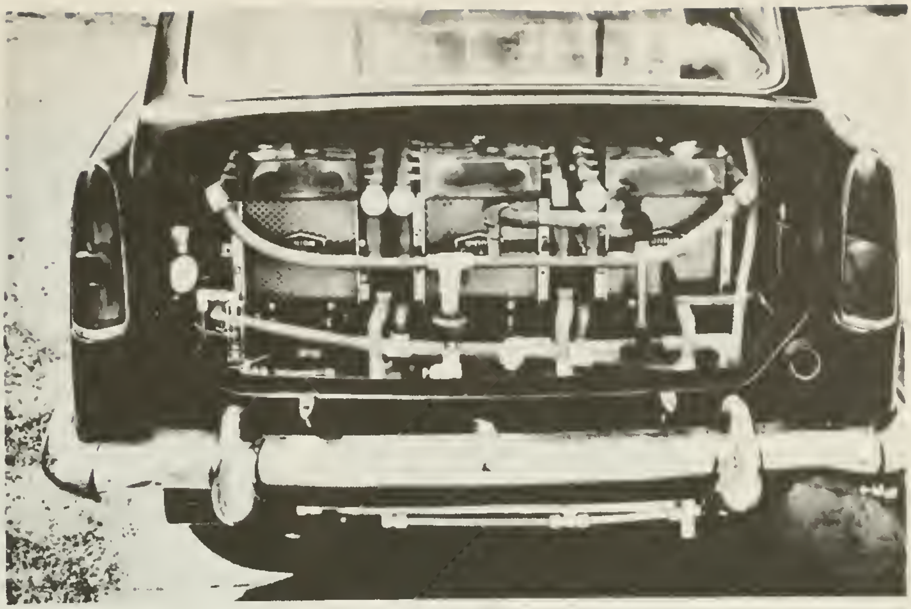
Department at the University of Illinois. The department members are working on the idea that present engines can use various other materials that contain hydrocarbons.

If these other materials could be converted into a fluid, (which includes gases) they could easily be oxidized in an engine cylinder.

The secret of obtaining successful operation of engines with the new fuels is guaranteeing a good mixture preparation, explained Richard Deller, a research assistant with the Mechanical Engineering Department. A good mixture preparation would insure a proper fuel-to-air ratio, along with equal distribution to all of the engine's cylinders. The fuel-to-air ratio for each type of fuel used, Deller said, would depend upon how many BTU's of energy would be delivered per pound of air used in the oxidation reaction. Deller added that for commercial use, fuels such as hydrogen gas, propane and alcohol would present some problems in the beginning.

Gasoline has been used in automobile engines for such reasons as safety, ease of manufacture and satisfactory power deliverance. Hydrogen, however, is highly flammable. It would have to be stored in the safest part of the vehicle. Fuels like propane would require careful pressurization. Alcohols tend to burn somewhat cleaner than oil by-products, but the production of large amounts is not economical. It would be possible, though, to blend some of these new fuels with gasoline.

An important point is that these alternatives to gasoline and oil fuels can be synthesized from other substances without taking on an identity as a naturally-formed product, never to be replaced again.



Fuel source H^2-AIR HYBRID'

In the event that the above problems with each of these alternative fuels are satisfactorily solved, many people may wonder what type of modifications to existing engines would be required. Stan Thomas, graduate research assistant for the Mechanical Engineering Department, has been involved in this investigation.

Mr. Thomas has been working with two other researchers on a hydrogen-fueled, 4-cycle motorcycle engine. It was found that since the flame velocity (a measure of how quickly a substance oxidizes) of hydrogen is on the order of 10 times that of high-octane gasoline, a few changes were necessary. The carburator assembly was rebuilt so that the hydrogen gas could combine in the proper proportion with air. The cam lobes were reshaped so that the valves were open for a shorter period of time. Finally, the timing was adjusted so that ignition occurred at approximately top dead center.

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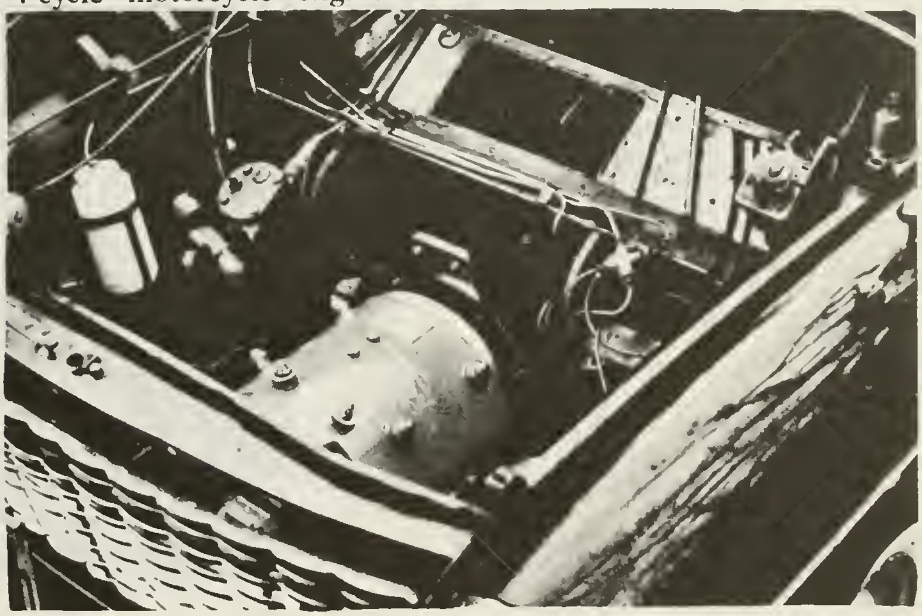
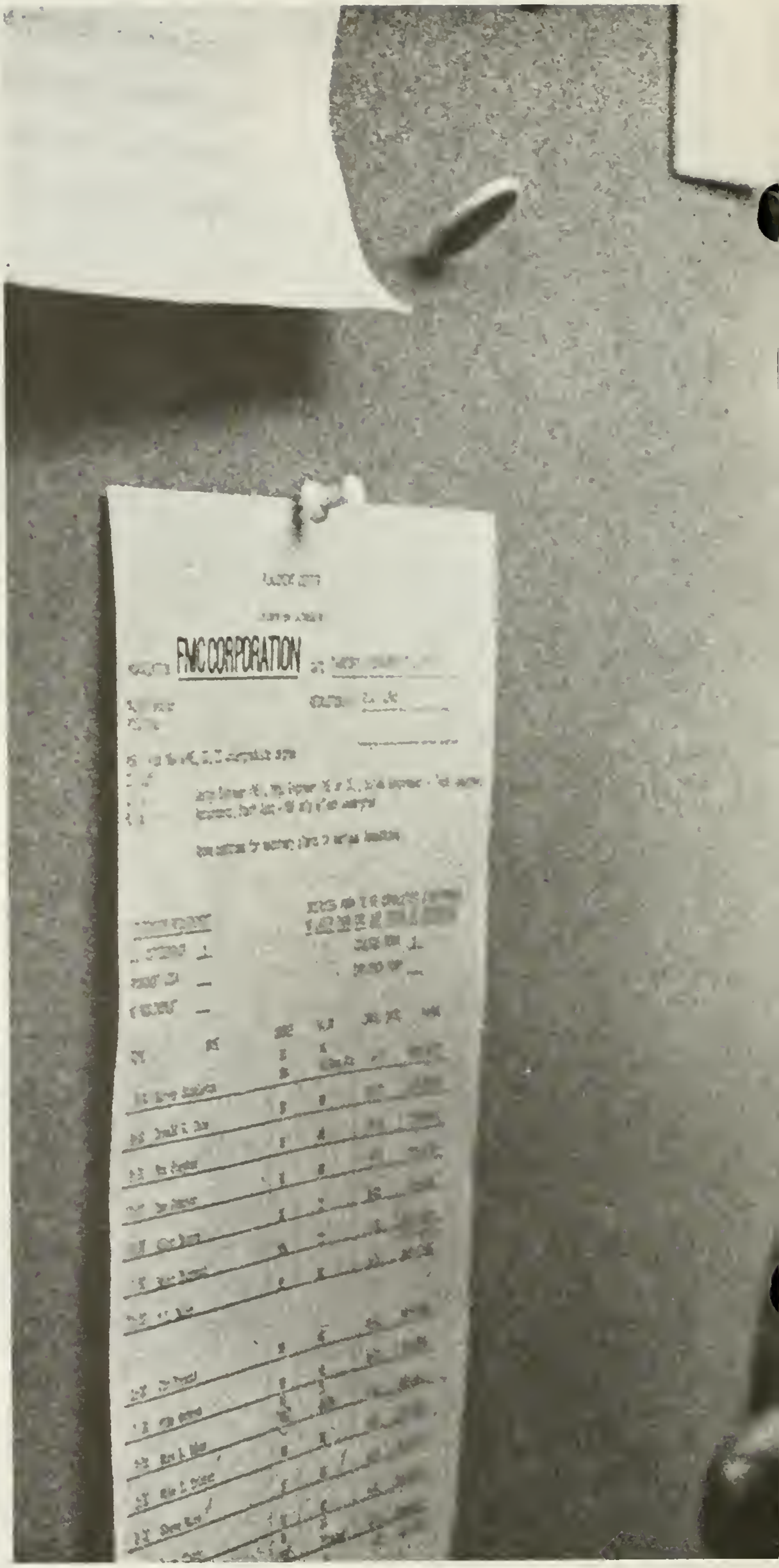


Don't let our name confuse you.



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The results were highly favorable. Engine knock was present in amounts that exist in the engines that operate on leaded gasolines. Dynameter tests indicated comparable torque and horsepower from this hydrogen engine.

Researchers at the University of California at Los Angeles have also been experimenting with their version of a hydrogen-fueled powerplant. Instead of making changes in the timing and cams, they have redesigned the present cylinder head to accomodate a water injection system. Water introduced into the cylinder in vapor form tends to lower the flame velocity of the hydrogen, and the amount can be monitored by a control system similar to that used in today's engines for providing electronic fuel injection. Therefore, the timing can remain at its previous setting.

At Brigham Young University, the high flame velocity problem has been rectified by adding an exhaust gas recirculation system to the hydrogen engine prototype. Part of the emissions is fed back to the cylinders at the correct time prior to ignition. Investigations have shown that the best method is as successful as introducing water vapor.

The studies performed at these universities show that present engines can have minor changes made to them so that they will operate on other substances whose hydrocarbon content is sufficiently high. For those individuals who are concerned about the fuel shortage, yet still want to operate their automobile, one last suggestion can be made. A small distillery could be constructed that would distill vegetables or grain in order to produce alcohol for fuel. Those frequent visits to the corner service station may soon disappear.

Coming soon in the Technograph...

What's new in Bioengineering,

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In the Engineering Rut?

. . . Broaden your outlook.

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A matter of breeding, and vice-versa

In the years ahead our nation will need to tap, in the most efficient ways, all available energy resources. An expanding economy, new industries and a growing population depend more than ever on large quantities of energy. Each American today uses 50 per cent more energy than he did just ten years ago. And this trend is expected to continue at least for the next several decades.

A promising answer to the challenge is the successful development and demonstration of the fast-breeder reactor--a new, more efficient type of nuclear power plant, which can extend our presently limited supply of uranium fuel for centuries. In his energy message to the Congress in June 1971, President Nixon called the breeder "our best hope today for meeting the nation's growing demand for economical, clean energy..." In doing so, he established its development as one of the key national goals of this decade.

Studies in reactors such as this one at the Nuclear Research Lab at the U of I provide basic information necessary in designing our future power systems.

HOW DOES BREEDER WORK?

The breeder reactor will be similar in many respects to nuclear-power reactors now in operation throughout the country. Breeders, however, are unique in their ability to produce more fuel than they consume.

The trick to "breeding" lies in a phenomenon known as transmutation of elements. In a nuclear reactor, when nuclear fuel fissions, it produces heat needed to generate electricity and neutrons. These neutrons react with ordinary uranium to produce usable plutonium. Today's water reactors produce small quantities of plutonium. In the breeder, however, the uranium is transmuted into plutonium at a faster rate than the plutonium is consumed. For every 10 atoms of plutonium consumed, 12 or 13 atoms of new plutonium are produced.

The time it takes a breeder to produce enough fuel to replenish its own plutonium needs plus those of one other reactor like it is called doubling time. Early model breeders are expected to have doubling time of about 16 years. More advanced breeders may ultimately reduce doubling time to about ten years.

The liquid-metal fast-breeder demonstration plant uses sodium, rather than water, as the reactor coolant. Heat generated in the plutonium core of the reactor is transferred to molten sodium, a liquid metal flowing through the core. Molten sodium is used because it will not slow down the neutrons vital to the breeding process in the core. The faster the neutrons, the more plutonium they produce. The sodium, in turn, transfers its heat to water in the steam cycle, converting steam to electricity via the turbine and generator.

ENVIRONMENTAL ADVANTAGES OF BREEDER

The breeder reactor will be highly desirable environmentally. Also, a major environmental advantage of the breeder over today's water nuclear plants is its better thermal efficiency. The higher operating temperatures and steam pressures of the breeder will result in lower thermal discharges into adjacent lakes and rivers. As with all nuclear plants, the breeder will not add combustion products to the atmosphere.

Because of the absorbent character of sodium coolant and the tightly sealed nature of the breeder reactor system, essentially all radioactive fission products will normally be retained in the breeder, collected, and disposed of off-site.

By the turn of the century this country will experience a seven-to-eight fold increase in the need for electric power. Nuclear energy will handle an estimated 60 per cent of this demand. With its environmental advantages, plus more efficient use of uranium fuel, the breeder will make possible maximum use of nuclear resources with minimum intrusion on the environment.

LOGICAL NEXT STEP

The breeder is a necessary next step in the use of nuclear energy to generate electricity. According to the most recent national power survey compiled by the Federal Power Commission, "The nation's electric power program of the next two decades is critically dependent on the successful introduction on schedule of tremendous increments of nuclear power." U.S. electric power requirements, for example, will quadruple between 1970 and 1990, and nuclear power, which accounted for only 2 per cent of the power supply in 1970, will account for over 50 per cent in 1990.

Water nuclear reactors have gained rapid acceptance because they have been highly competitive with fossil-fueled plants in most parts of the country. However, today's reactors consume enriched uranium fuel--an item that can become extremely expensive or scarce in the future, unless the breeder is developed.

The breeder can use, for fuel, plutonium by-products of a water reactor. Moreover, the breeder produces fissile fuel from depleted uranuim, and, in effect, takes otherwise unusable residual uranium from a water reactor's spent fuel and produces new plutonium fuel that in turn can be used to run other water and breeder reactors.

The breeder's ability to use uranium fuel more efficiently makes it an important conservation tool. In comparison with present water reactors, which capture only 1 per cent or 2 per cent of the energy potential available in uranium, the breeder is estimated to capture from 60 per cent to 80 per cent of the potential energy.

In future years, breeders and water reactors will work together, sustain each other with a shared fuel cycle, conserve valuable, non-renewable

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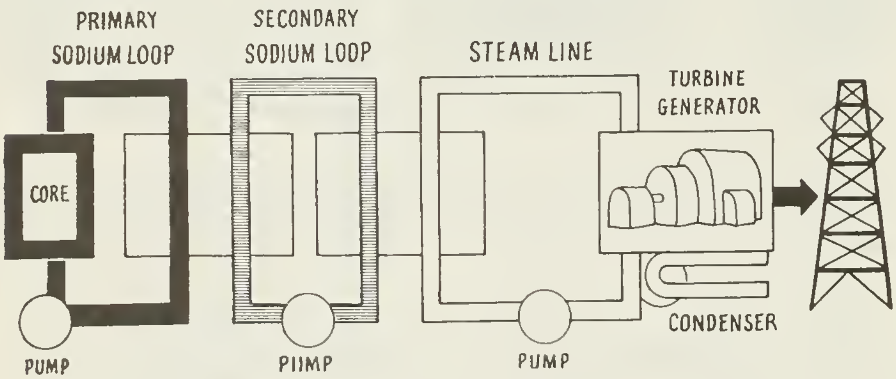
DEMONSTRATION PLANT FLOW DIAGRAM

Liquid Metal Fast Breeder Reactor Nuclear Power Plant



Liquid-metal fast-breeder reactor system will have three basic loops. Unlike current water reactors that use water as coolant, breeder will use liquid solium which will be pumped through reactor core to remove heat. Through heat exchangers, heat will be passed on to secondary sodium loop, which will heat water in steam loop leading to turbine.

A Matter of Breeding, and Vice-Versa

(Continued from page 18)

uranium resources and, therefore, keep the cost of electric power low.

PROPOSED DEMONSTRATION PLANT

A 300 to 500 megawatt breeder demonstration plant will be built on the Tennessee Valley Authority system at Oak Ridge, Tennessee, as a research and development project, with ground breaking planned for 1974. The project will be an unprecedented cooperative effort by the U.S. Atomic Energy Commission, the nation's electric utilities--both government and investor owned--and the large manufacturers of power generation equipment. Estimated cost is about $500 million.

WHY DEVELOP BREEDER NOW?

Breeder technology must be demonstrated to be feasible, economic and reliable for utility systems before it can be adapted to commercial power generation. Water-reactor demonstration plants such as Dresden 1 operated for nearly five years before utilities made major commitments to nuclear power.

The fast breeder reactor today is in a position similar to that of water-reactor technology in the 1950s. Thus, even though much is known about breeder technology, the complexity and size of the program requires that work on the demonstration plants begin immediately. mediately.

Substantial research and development work already has been conducted on breeders. In 1951, Experimental Breeder Reactor 1, built by the AEC in a remote Idaho site, became the first nuclear reactor to produce electric power. Though the electrical output was very small, it symbolized the beginning of the nuclear industry. Operation of Experimental Breeder Reactor II began in 1961. The plant first produced electric power in 1964.

It has operated successfully for over seven years and has produced over one billion kilowatt-hours of electricity. As an experimental plant, it has shown breeders to be technically feasible and environmentally clean. This reactor today is involved in tests for fuels and other materials destined for use in the demonstration plant and the fast-breeder program.

In addition to a broad U.S. breeder program, other countries, including the United Kingdom, France, West Germany and the Soviet Union are actively pursuing breeder research. Small demonstration plants are already operating in the United Kingdom and France. The Soviet Union recently completed construction of a 150 megawatt fast-breeder reactor; a larger demonstration plant now under construction is scheduled for completion in 1976. The speed with which large commercial fast-breeders can be inroduced in this country will be determined by the success of the present demonstration-plant program.

Other potential power sources, such as fusion and solar power, will require even longer development periods. Thus the breeder will fill an urgent national need to supplement present methods of power generation.

(Continued from page 7)

will analyze the job in detail. The engineer must interpret the interviewer's responses in light of his position-a personnel manager, an engineer or a business manager. The interviewer is looking for competent, mature engineers who could be an asset to his organization. Let the interviewer know your interests-tell him the types of problems you would like to solve and the challenges you want to meet.

If you should take a plant visit, this is the time to really sell yourself. Enthusiasm and realistic evaluation of your talents often sell better than high grades and a blase attitude. The engineer should be prepared to answer technical questions in his field. An important part of the engineer's selling job is to establish himself as a communicator. Ask questions about the firms marketing and advancements — be concerned.

Probably the most important thing to remember is to be alert. Much about the company will be said and it is up to the engineer to keep things straight. If something is not fully understood, ask questions.

When making the final decision, the engineer must remember things such as responsibility, recognition and reward.

Don't be placed in a job, place yourself.

When, in danger or in doubt, run in circles, scream and shout!

How would you like to sign the work you do?

Would you be willing to tell the world, "I did this?"

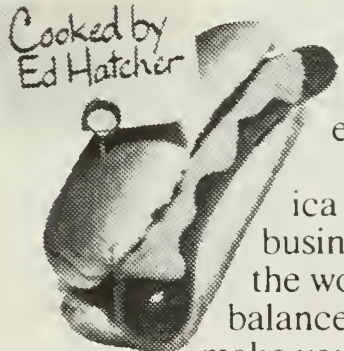
After all, you're pretty good at what you do. Probably proud of it, too.

Well, most of us will never get to sign our work. And maybe that's a shame. Because as good as we are, it might make us better. And we can afford to be. Whether we're teachers or short-order cooks, farmers or steamfitters, sales managers or city managers.

We'll all have more to show for it.

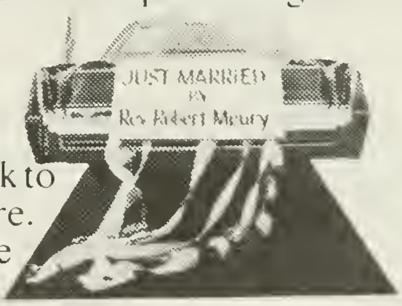
More money, for one thing.

Because we'll be giving each other our money's worth for the products, the services and even the government we pay for.



For another thing, we'll be giving America a better chance to take on our foreign business competitors. Not just here. All around the world. That would help bring the lopsided balance of payments back onto our side. And make your dollar worth more.

Best of all, as we hit our stride, we'll be protecting jobs here at home. For ourselves and the future. And we'll have a deeper sense of satisfaction in the jobs we've got.



You don't have to sign your work to see all these things happen. And more.

Just do the kind of work you'd be proud to have carry your name.

America. It only works as well as we do.

The National Commission on Productivity Washington, D.C.

CHECK OUR SPECS BEFORE YOU BUY THEIR 4 CHANNEL RECEIVER.

	Sylvania	Pioneer	Sansui	Fisher	Harman-Kardon	Marantz
Model	RQ 3748					
Continuous (RMS) Power[1] 4 channels Stereo Bridge	50W x 4 125W x 2					
THD at rated output	<0.5%					
IM Distortion at rated output	<0.5%					
FM IHF Sensitivity	1.9μv					
50 db signal to noise ratio	2.8μv					
Capture Ratio	1.5db					
Price	$549.95[2]					

[1]All power measurements taken at 120 volts/60 cycles, 8 ohms, 20Hz-20kHz, all channels driven simultaneously.
[2]Manufacturer's suggested list price which may be higher in some areas.

If you're in the market for four channel, you already know you've got to spend a good bit of cash for a receiver. So it'd be a good idea to spend a good bit of time checking specs on everything available just to make sure you get the most for your money.

To make your search a little easier, we've prepared the blank comparison chart above with spaces for some of the best-known brands and most important specs. Just take it with you to the store, fill it in, and you'll be able to tell at a glance what you get for what you pay.

We took the liberty of filling in the Sylvania column with specs for our RQ3748 four channel receiver. We did it because we know we're not the best-known name in four channel, and we didn't want you to overlook us for that reason.

Because we think the RQ3748's specs are really worth remembering.

50 watts of RMS power per channel at 8 ohms, 20-20kHz, with all four channels driven. 125 watts per channel in stereo bridge mode. A THD and IM of less than 0.5% at rated output. An FM sensitivity of 1.9 micro-volts. A discrete four channel receiver with matrix capabilities so you can use either type of quadraphonic material. And much, much more.[3]

We can offer so much because we have so much experience. We were one of the first in the audio field. And now we're applying all our knowledge, all our engineering skill to four channel.

Once you've proven to yourself which receiver has the best specs, move on down to that last line in the chart and compare Sylvania's price with all the others. Find out which one gives the most for your money.

We feel pretty confident you'll discover that the best-known names aren't necessarily your best buy.

[3]So much more that it won't all fit here. So send us a stamped, self-addressed envelope and we'll send you a four-page brochure on our four channel receivers.

GTE SYLVANIA

Sylvania Entertainment Products Group, Batavia, N.Y.